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Continental "Engineering Skill."

In the pursuance of our mission to point out the most effective means of retaining and expanding British trade, it has been necessary for us more than once to direct attention to the state of development achieved in engineering work by various foreign nations. That course was dictated by the fact that a couple of years ago British industrial firms appeared to be so far satisfied with past successes as to be somewhat neglectful of the wonderful advances made by other nations—their former pupils. Our efforts have not been without due appreciation, and we believe they have done something to stimulate industrial energy in this country. Unfortunately, the general interest awakened by our articles had a most exciting influence upon the minds of impressionable journalists responsible for the production of daily and weekly news-sheets. In papers of this class there have been reproduced from foreign journals every available paragraph tending to the detriment of British engineering work and machinery, and in many of them writers of exalted imagination and profound ignorance have been allowed to discourse without restraint or guidance. The injury done to our trade by sensational journalism of this sort is greater than its authors imagine, and we invite their attention to the following instances of "foreign engineering ability." As a first example we will take the collapse of the bridge over the Avenue Suffren in Paris. This disaster occurred in the month of April last year, but the report of the experts charged with the investigation of the matter has only just been made public. It will be remembered that the bridge consisted of two approaches, having six spans built up of armoured concrete, and supported by pillars of the same material; over the Avenue Suffren there were a central span of about 57 ft. and two smaller spans. Steel cables passing over the piers served to support the armoured concrete side beams by means of vertical rods, certainly a most original if not a particularly desirable device. From the evidence of the consulting engineer to the Société du Globe Celeste, for whom the bridge was built, it appears that the Société du Fer-beton was asked to prepare the calculations for a foot-bridge in armoured concrete; that in the drawings received, the supporting pillars were shown to be 12 ins. square; that it was pointed out to the engineer to the contracting firm that deviation from the straight line originally intended would be necessary in order to avoid a clump of trees; and that this deviation was approved. It should here be remarked that the bridge was erected by the general contractor to the Globe Céleste Company, and under the daily supervision of the consulting engineer to the same body. Therefore the engineer to the Société du Fer-beton claimed to be exempt from all responsibility except for any scientific errors in his calculations, and this contention is borne out by the terms of the contract. He admitted that he had never prepared complete drawings, but merely rough drafts. On these, the dimensions of the pillars were proved to have been 16 ins. square, and not 12 ins. square, as stated by the consulting engineer. The engineer further said that he had never taken into calculation the bends or breaks due to the deviation, and on this point his evidence was at direct conflict with that of the consulting engineer. Finally, the contractor who erected the bridge acknowledged under examination that he did so in the absence of proper working drawings. Looking at matters so far as

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we have gone, it is clearly shown that the rough sketches were accepted by all the responsible parties in lieu of proper drawings; that even these sketches were not correctly interpreted; and that the effect of a most important alteration was never considered. Further, it transpired in the course of the inquiry, that the public was allowed to pass freely beneath a structure which had not been tested in any way, and which collapsed under its own weight. In the opinion of the experts, the method of suspension was dangerous, as no adequate provision was made for resisting oblique strains, and that the collapse was mainly due to the flexure of the pillars under the oblique stresses to which they were subjected. The circumstances stated above certainly reveal an extraordinary laxity, which it would be difficult to imagine possible in this country.

Turning from France to Germany, we may quote the criticism forwarded by a correspondent in the latter country. He says, "The principle they work on here is cheapness rather than stability," and instances an important bridge over the Weser, in Bremen, which deflects to the extent of three or four inches under the weight of a cab, and is continually under repair, although only completed four years ago. Work of this kind is never to be found in Great Britain, and the daily press never contains an allusion to such flimsy structures, simply because foreigners are too wise to offer damaging evidence of incapacity to editors of the "scissors-and-paste" variety in other lands.

Another interesting comparison may be drawn from a recent case in which a complete installation of elevating and conveying plant, "made in England," was supplied to, and erected in, Germany. The engineer sent out to superintend operations found all the individual parts of the apparatus to be finished in so accurate a manner that they dropped right into place without the necessity for any cutting or fitting, and he had not to drill a hole in any single part. Yet he found innumerable mistakes in the structural work of the building executed by German "engineering skill." These mistakes are said to be "awful to contemplate," and those in connection with the elevating plant alone are estimated to cost about £300 to put right. That portion of the press which presumes to instruct the public on engineering matters knows nothing of blunders made abroad. The serious industrial crisis in Germany is another topic concerning which our self-constituted mentors are totally indifferent; but if the crisis happened to be at home we should doubtless read many wild articles on British decadence, and so forth.

The "Hyacinth" and "Minerva" Trials.

THE reports of the results of the *Hyacinth* and *Minerva* trials which have appeared deserve attention. Although the Scotch boilers fitted in the *Minerva* are not of recent type, their consumption of coal per unit being high, and their weights much greater than modern cylindrical boilers of the same power, they may be taken as suitable to compare with the Belleville boilers, with which the *Hyacinth* is fitted. To begin with, the two cruisers are sister ships, and require the same power to propel them at a given speed. This was brought clearly out in the first series of coal consumption trials, when with 2,000 h.p. developed in each the speed was 12 knots, and with 5,000 h.p. the speed was 16 knots. With 8,000 h.p., however, the speed of the *Hyacinth* was 18½ knots, while that of the *Minerva* was 18 knots. In order to compare the evaporative efficiency of the two types of boilers, the feed water was measured. Had there been no leakage from the boilers, or had the leakage been the same in each case, this method would have been a good means of comparison. But, unfortunately, there was no end of trouble in the case of the Belleville boilers, due to leakage. To get over this difficulty, arising in the race back to Portsmouth, the double bottom of the *Hyacinth* was filled with fresh water, apparently without better results. As there was no such leakage with the Scotch boilers, clearly

the water measured in the case of the Belleville boilers did not measure only the evaporation but the leakage as well.

It is better to take the coal consumption per horse-power hour to test the two systems of steam raising. And when comparing the consumption of coal of the Belleville boilers with that of the Scotch boilers it is fair to make the comparison, in the first place, not with the *Minerva* boilers, but with those of modern construction and fittings. The usual practice in coal consumption is from 1·3 lbs. to 1·5 lbs. of coal per horse-power per hour on first-class liners fitted with modern Scotch boilers. In some cases it is less. Taking the actual results of the trial, however, the victory still remains with the Scotch boilers. At her cruising speed of 16 knots, and when developing 5,000 h.p., the consumption of coal on the *Minerva* is given as 1·74 lbs. of coal per unit, while the corresponding consumption of the *Hyacinth* boilers was 1·84 lbs.

The second trial to determine the respective merits of the two systems as to "their capacity for producing an ample and constant supply of steam for a long run at maximum speed, having no special regard to economy of fuel," resulted in the same trouble being experienced on board the *Hyacinth* in consequence of leakage. It was found almost impossible to supply the boilers with fresh water, and, according to a correspondent on board, after steaming for 103½ hours at 7,000 h p. she was obliged to put into Gibraltar, owing to leaky feed connections. This test was sufficient to determine the *Hyacinth's* cru sing radius, as measured in time, to be 103½ hours, as against 150 hours of the *Minerva*, which vessel was, moreover, ready to put to sea again immediately her bunkers were filled.

The third test applied was to determine which system could supply steam best for a full-power run of over a thousand miles.

In this third contest the Belleville engineers prepared for eventualities. They had been troubled with loss of water in the previous trials, and even encroached on the drinking water. This time they filled the double bottom of the *Hyacinth* with fresh water, in order that they might not wholly rely on the fresh-water making machinery.

At the beginning the tubes were thoroughly cleaned, steam was raised in three-quarters of an hour, and in 12 hours' time the *Hyacinth* was 9 knots ahead of the *Minerva*. A fog bank was then run into by both cruisers, after emerging from which the *Minerva* drew away and increased her lead at the rate of 1·3 knots.

It is reported that later the *Hyacinth* made a spurt of three hours at 10,000 h.p. Curious things are seen and done with indicator cards, and it is doubtful whether after she had been running for some 20 hours she could make 10,000 h.p. During this test, with a spurt of 10,000 h.p. "she merely churned the water, without appreciably increasing her speed." All the time we are told the *Hyacinth* was developing 1,000 more h.p. than the *Minerva*, the latter "increased her lead at the rate of 1·3 knots."

Later on, the two cruisers, on emerging from a third fog bank off Ushant, again put on full steam. The *Minerva* drew out of the fog an hour before the *Hyacinth*, "and increased the lead by half-an-hour by the time Spithead was reached." In spite, therefore, of the reported 1,000 more h.p. developed by the *Hyacinth* engines, the increasing lead was maintained.

It is of interest to consider the state of things on board the *Hyacinth*. It is clear that feed-water troubles were becoming worse as Portsmouth was neared, as is evident from the fact that a stoker was severely scalded through the bursting of one of her boiler-tubes when the cruiser was in the Channel. The fact was, of course, that the condition of things was about the same as at the end of the 103½ hours' steaming off Gibraltar, when she had to go into port—the bursting of the tube and scalding of a stoker being the harbinger of an early full-stop.

Indeed, the race home supplies the usual story, and the chief lesson of the trials is to lend additional weight to the views of those who hold that Belleville boilers are dangerous to H. M. stokers, excessively wasteful in fuel, cannot maintain

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a moderately high speed for more than about 80 hours, and do not compare well with the old type Scotch boilers.

Storage Batteries in Electric Power-Stations.

THE question as to where the balance lies between the advantages and disadvantages of employing storage batteries in direct-current electric power-stations. other than those of the smallest size, was for a long time a subject of hot controversy among electrical engineers.

Ten years ago the prevalent opinion was that the disadvantages so far outweighed the advantages that, except in the very smallest stations or under quite exceptional circumstances, their use was doomed.

Their advantages are more immediately obvious in the case of smaller stations where it is impossible, without their use, to keep the load on the generators constant, and where, besides taking charge of the peaks, they can generally be made to save one shift in the twenty-four hours by taking charge of the load from midnight until 6 a.m.

In large stations, on the other hand, three shifts are necessary under all conditions, and the constancy of load on the generators can be maintained without any difficulty by the employment of groups of generating units of two or more different sizes.

There are, however, few electric power-stations in which a constant boiler load can be maintained without the use of accumulators, except, perhaps, in the case of those used exclusively for traction systems on which a large number of cars are in constant use throughout the working hours.

Even in this case the batteries will be of value in sub-stations on the various routes, in order to keep the load constant on the feeders of those routes.

Until quite recently the only method employed for maintaining the pressure from a battery during discharge has been the regulating cell system, and these cells are always a great source of trouble.

Whatever system is adopted for charging, it is a matter of practical impossibility to properly charge the regulating cells, and the result is that, with the exception of the two or three end ones which are rarely used, they depreciate at a much greater rate than the rest of the battery. The group of regulating cells forms, moreover, a portion of the plant from which an abnormally small proportion of work is obtained, and the heavy switch gear and connections are very costly and difficult to operate satisfactorily.

Another source of trouble, especially in stations which have outgrown their battery capacity, is that the battery is scarcely ever out of use for any length of time, and it becomes a difficult matter to find sufficient time for charging it. The result is, that the cells are habitually run too low and the depreciation thereby greatly increased.

During the last few years more or less successful attempts have been made by several station engineers to overcome these difficulties by doing away with the regulating cells and maintaining the constancy of the battery pressure by means of a reversible booster.

An admirably devised system of this kind, which has proved thoroughly successful under practical working conditions, has recently been brought before the Institution of Electrical Engineers in a paper by Mr. J. H. Highfield, who has thereby done a very real service to the electrical profession.

Mr. Highfield's variable pressure booster is so designed that, by varying the field, the pressure can be varied from zero to a maximum in either direction, a double-wound armature working in a single field being employed.

In the arrangement first designed the field of the booster was varied by hand, by means of a 30-point rheostat, and a reversing switch interlocked with it in such a way as to vary the volts given by each armature from 0 to 50, and this he found a very great improvement on the regulating cell system. More recently he has devised an automatic method of varying the field, which acts in such a manner that if the speed of the generators

is arranged for a full load at the correct pressure, then by regulating the station pressure by the booster and battery the generators will always, in an almost automatic way, be kept at full load, provided always that the battery is of proper capacity.

This continual charging at every possible moment when the conditions make it possible, not only has the effect of keeping the battery in good condition, and thereby increasing its life, but has also, in Mr. Highfield's experience, raised its efficiency to the unusually high figure of 74 per cent., and some 10 per cent. higher still when working on an intermittent load.

The latter effect he attributes to the utilisation of the increased pressure, due to the gas effect, in consequence of the frequently very short duration of the charges. The generally high efficiency he considers to be due, in part at least, to the great ease of operating attained by this method of regulation.

Our Canal System.

It is a matter for congratulation that our canal system, which was for so many years ignored and allowed to decline, has of late years begun to receive attention once more from manufacturers and commercial men. It is now recognised that it is wrong to look upon the canals as rivals to the railways; and that the one should be rather the help-mate of the other. Thus for passenger traffic and for speedy transport of goods the railway alone is suitable; but for heavy and bulky goods, where time is not of first importance in the contract, the canal with its much cheaper freight-rates is to be preferred. It is through the failure of the owners of the canals of sixty years ago to recognise this to be their proper function, that we owe the present unfortunate position. When railways were introduced, receiving at once the approbation of the public who had formerly been as enthusiastic over the canals, the owners of these water-ways continued for some time to try to hold their own against the railways, even in the matter of passenger traffic; then, when they found this to be impossible, they suddenly took fright and actually sought to compel the railway companies to buy up their canals, although some were paying a dividend of 30 per cent. Thus between 1845 and 1847, the railway companies were allowed to purchase 948 miles of water-ways, and this was gradually increased to a much larger figure. It is true that by the act of 1888 it was provided that railway companies should not acquire ownership in canals without statutory authority, but this was rather like locking the stable after the horse is stolen, for by that year nearly one-third of the total length of British canals had come into the hands of the railway companies. These canals form links in the through-routes of communication, so that by holding them, the railway companies can, and do, prevent any amalgamation of the different authorities, thus excluding the factor which has been most powerful in the development of the railways themselves.

Our canal development is not what it should be. We require not only the gradual elimination of railways from ownership, but also a remodelling of many of our canals. In many cases the routes are too circuitous for economy, and there is a want of uniformity in the gauge of canals and of locks. If these can be widened to take boats of heavier tonnage, more economical conditions of transport can be obtained. The Aire and Calder Canal was originally built with locks of dimensions 60 ft. by 15 ft. by 3 ft. 6 in.; now the locks are 215 ft. by 22 ft. by 9 ft. and the yearly income is now as large as the original total capital.

Germany is now doing all she can to develop a complete and modern canal-system. The Rhine-Elbe Canal scheme has not yet been made law, but it is well known that the Kaiser means to have it, and that in due time it will be carried out. At the present time it is opposed by the agrarians in the east country who imagine —probably erroneously—that the canal will be used for the importation of American food-stuffs to compete with home produce. There can be no doubt, however, that the scheme will be of the greatest importance in opening up a way

to the sea for the industrial products of Germany. In a pamphlet published in 1898, and dealing with this canal scheme ("Die Mittellandstrecke des Rhein-Weser-Elbe-Kanals," by Fritz Geck, Engineer), the author points out that the chief advantage gained will be the providing of cheap freights for heavy and bulky goods and the consequent disburdening of the railways, which cannot overtake the traffic. He shows that in the industrial Ruhr district, one station almost joins itself to the next, and that the ten principal central stations there contain 500 kilometres of track, a length greater than that of the whole Rhine-Weser-Elbe Canal. Cheaper freights are needed to enable German goods to compete on the world's market, and these will be obtained on the canal; while the railways, freed from this very heavy and slow traffic, which causes the block at present, will be able to devote themselves to the passenger and light goods traffic for which they are specially suited, and which is most profitable to them. Mr. Geck calculates — showing all the figures on which his calculations are based—that there will be an annual saving in freights of £1,000,000 sterling.

In this country we must trust to private enterprise for such schemes, and it is therefore satisfactory to see the attention of the public being once more directed to the value of canals. A ship-canal from the Severn to Birmingham has for many years been spoken of. Perhaps now that the Manchester Ship Canal promises to be financially successful, something more may be done to have this new scheme developed. It is matter for regret that the Forth and Clyde Canal should be in the hands of a railway company. A good ship-canal on that route would no doubt, in time of war, be of strategic value to the Navy; but failing this, a canal wide enough to take boats of dimensions giving best economy of transport, would show a great increase in traffic over that conveyed by the present canal. We trust that the Associated Chambers of Commerce and other commercial and industrial organisations will endeavour to devise a scheme for a more uniform, more modern, and more economical system of canals, and have it pressed upon the government in the form of a Bill.

Maximite.

A HIGH explosive practically insensible to shock, and not subject to explosion even if subjected to an extremely high temperature, an explosive, in fact, not developing its deadly power except at the very moment desired, is, it will be granted, in these warlike times a weapon of incalculable value, which must add considerably to the military efficiency of the Power that possesses it. From recent information it appears that the Government of the United States are in the enviable position of having acquired such a compound, and, on the authority of the *Scientific American*, our able and esteemed transatlantic contemporary, whose high reputation forbids us to question the correctness of the facts for which it vouches, some extraordinarily successful tests have been made within the last few weeks at the Sandy Hook proving-grounds with this new explosive, which is called Maximite, after its inventor, Mr. Hudson Maxim, of New York. These Government tests consisted in firing shells of all sizes, from 6-pounders up to 12-inch, filled with Maximite, at armour-plates of from 3 ins. to 12 ins. in thickness, with the result that the charge exploded, not as in the *Majestic's* bombardment of the *Belleisle*, on the outside, but inside the armour, after penetrating it, just beyond it. This achievement is quite unparalleled, in the United States as well as in Europe. When it is stated that Maximite is said to be more powerful than wet gun-cotton and equal in effect to nitro-glycerine and picric acid, we can well comprehend that the results are said to have been highly gratifying to the military authorities. There is no doubt that picric acid enters into the composition of the new explosive, and that it consists largely of picrate, but its exact composition and the combination of the ingredients are, of course, a jealously-guarded Government secret.

The Position of Experts.

SURELY every engineer occupied in the work of advising commercial men upon the technical aspect of their undertakings will feel very familiar with such expressions as those used by Lord Salisbury in commenting upon the interesting duel between Viscount Wolseley and the late Secretary for the War Department. The conflict between the expert and his lay critic is as old as the hills, and probably as durable, as its cause lies in the ineradicable weaknesses of human nature. The lay critic having superficially considered—at much trouble to himself—some technical question, and having formed a strong opinion thereon, is annoyed to find, as Lord Salisbury puts it, that "things which they [the experts] elevate to great magnitude do not strike the civilian mind as being of the same importance." Why not? Let the expert reply. Because he, having devoted his life and energies to the consideration of a certain class of problems, has attained a knowledge and power of rapid judgment (the reasoning being often sub-conscious) that enable him to view technical matters in their proper proportion—a power which is denied to the superficial student.

Military men and engineers have much in common in their methods. In both professions discipline and the strictest departmental subdivision must be carried out to ensure frictionless working, and the rigors of such systems are inexplicable to the lay critic, who views them as merely the fads of the academic mind.

Let it be admitted that the pressure of commercial considerations upon the plans of the designer is an excellent check to restrain the exuberant theorist from indulgence in rash experiments, and is in such cases an influence entirely salutary; but the expert who cannot or does not work strictly for the interest entrusted to him by his client *in all its aspects* is unfit for his duties, and should not be employed in such a capacity. In any case the determination of the point beyond which the subordination of technical to commercial considerations becomes dangerous to the latter must be left to the expert, and it is difficult to see any other reason for his employment.

In no department is this more obvious than in the construction and running of steamships. The shipowner rightly looks upon a steamship simply as a dividend-producing machine; but when he adopts the views expressed by Lord Salisbury in the extract at the head of this article and ignores the advice of the expert he has chosen, he is guilty of an illogical action that will sooner or later cost him money, if his adviser be honest and competent.

The results of this attitude are seen upon every hand. In the endeavour to obtain a high carrying capacity upon small dimensions a light model for tramp steamers has been evolved which has almost lost the characteristics of the ship form. It is true that this evil has been reduced to a minimum by the great skill shown in many quarters by builders in making the very best of the conditions, and producing models having co-efficients of ·8 and upwards that show surprising results both in appearance below the water-line and in work afloat *in favourable conditions*. These results are too often taken as typical of the all-round work of such ships, and excuses are found for the bad work against head winds and adverse conditions, and it is straightway forgotten.

A glance at the daily runs of such a vessel and their fluctuations in adverse weather might give pause to the boldest lay critic, and cause him misgivings as to whether he had not failed to appreciate the wisdom of the expert, who considered the question of form to be one of "great magnitude."

But your lay critic recognises no facts or figures that are not apparent upon the face of the balance-sheet, and conversely is frequently hoodwinked by economies that are *apparent only*, but require probing by the expert before their fallacy is discovered. A case recently occurred where a certain fitting had been furnished to a steamer that "saved 25% " of coal; and this saving was duly shown by "the books." A blank flange upon the arrangement caused no falling off in efficiency, and further inquiry showed that the cut-

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off had been altered when the arrangement was fitted, no note having been taken by the "commercial" men of the reduced speed, which was put down to weather, bad coal, &c. This fitting was one of the things which "appear to the professional members of very small importance," but appeared to the lay critic as of "considerable moment."

To take another instance, the question of lightness of structure is one that must always present itself differently to the expert and the commercial man. The commercial man needs light draft, large dead-weight capacity, and large hatchways, and has no compunction in reducing scantlings to a minimum, or cutting away the top flange of the ship-girder until he gets them. Let the structure only meet the minimum requirements of classification, and the commercial man is perfectly satisfied. The expert, with a deeper knowledge of the inefficiencies of so-called "compensation," knows the risks run by such a structure in heavy weather, and also the large repair bills that follow the "working" of a weak ship. Turning from the structure to the running of steam-ships, the case in favour of the expert is even stronger.

Taking first the boilers: how many shipowners treat them in such a way as to reduce their life to one-quarter of what it should extend to with due care! Steam raised hurriedly, scaling neglected, leaks left to chance, until a small matter that the expenditure of £5 would have rectified becomes a defect that results in a boilermaker's bill that may run into hundreds of pounds, and the only asset to place against all these losses is a few hours saved (and probably lost again), while the strained, patched, and corroded boiler finds its way to the scrap-heap when it should be as good as new.

The argument could be amplified by instances almost indefinitely; but surely they are unnecessary! The conclusion is plain, but, we fear, unsatisfactory to the lay critic. It is that the only possible course is to select a capable and trustworthy adviser, and give him control of his own department absolutely, holding him personally responsible for all matters within it. Doubtless this is a hard saying to the clever man of business; but the honest expert knows that it is the most profitable to his employers, and although there are many Lord Salisburys who think it "strange," and object to what they consider the "tyranny" of the expert, there is no other position possible until the client learns the expert's business, which, with the start of a lifetime to overtake, he is not likely to do.

Scarcity of Platinum.

An incident worthy of the attention of all electrical engineering firms was a recent debate in the German Reichstag on a bill drafted with the object of obtaining a legal prohibition of the use of platinum where it can be replaced without serious inconvenience by some other metal, as, for instance, in photography, where it is utilised for so-called platinum prints; and to limit its consumption to cases where its employment is essential. This debate struck a note of warning regarding an imminent danger, the full import of which appears not to be fully realised even among those who ought to be most concerned, but the restriction of the use of platinum in one country alone is hardly a practical measure for averting the dreaded consequence of a platinum famine. The problem is one of those that are eminently fitted for an international agreement, and should be carefully investigated by a commission composed of experts from all civilized countries. The steadily and rapidly growing scarcity of the metal, and the increase in price resulting therefrom, fully justify the anxiety in well-informed circles that the supply may be exhausted ere new deposits, sufficient to satisfy the demand, have been discovered. Excepting perhaps iron, tin, copper and lead, there is no metal that plays a more important part in modern industries at present than platinum, although its extensive employment is of very recent origin. Thus in the great chemical manufacturing processes

there are operations in which it is practically indispensable, as, for instance, that of purifying sulphuric acid, for which platinum retorts are used—each of which frequently represents a value of £2,000 or more—or various operations on which the accuracy of chemical analysis depends. Equally, or rather even more, important is the use of platinum in electrical engineering processes, or in the manufacture of electrical apparatus, and in the enormous number of incandescent lamps this metal has, as all our readers are aware, a very important function. It is, in fact, the only metal known around which glass can be fused If we add to this, that it withstands abnormally high temperatures and that no acids, excepting aqua regia, will attack it, it is easily comprehended that, unless a substitute combining these qualities be discovered, the exhaustion of its supply would have a serious effect upon more than one industry. Even at present its scarcity must result in considerable increase of cost in many branches of technical work, for the price of platinum has greatly risen.

A Step in the Right Direction.

THE building of the steamship *Port Antonio*, and that of her sister vessel, *Port Royal*, having completed her second voyage, mark a step in the right direction, namely the granting of a government subsidy for the building of vessels that are to serve for the development of our trade. Such subsidies have become practically a duty now that other nations have successfully entered the arena of international competition in trade and commerce, and are using every means in their power to oust us from the position that until recently we have been occupying. The idea of this subsidy, we understand, originated with Mr. Chamberlain, and its realisation will be welcomed, not only by his friends, but also by the most clear-sighted of his political opponents, as it is an act of justice toward a portion of the British empire that has been brought to the verge of ruin by the stubborn adherence to our fiscal policy in spite of directly hostile acts of other nations as regards our commerce. The steamships *Port Antonio* and *Port Royal* will serve to establish a regular fast sailing trade between this country and the British West Indies, where, notwithstanding the extreme fertility of the soil, trade and agriculture are stagnating owing to the utter destruction of the cane-sugar industry, in consequence of the continental bounty system. The direct object of the new enterprise is to develop, as a substitute for the sugar industry, the fruit trade of Jamaica, which appears to promise phenomenal profits if placed in the hands of competent persons. The main obstacle to its development heretofore has been the absence of efficient means of transport, *i.e.*, of vessels capable of making the journey from and to England within a reasonable time, and fitted with all modern appliances, notably a cold-storage plant, so as to make it possible to place the luscious fruit, of which the islands produce an almost incredible amount annually, in a fit condition upon the European markets. By means of the government subsidy of £40,000 per annum it has been made worth their while to Messrs. Elder, Dempster & Co., of Liverpool, to give out a contract for the building and equipment of the two steamers above named in the most efficient style, and the result has been that, owing to the engineering skill of Sir Raylton Dixon & Co., Ltd., of Middlesbrough, the new line makes a start with two first-class twin-screw steamers of which any country might be proud. Their speed is to be 15 knots, and the triple-expansion engines by means of which it is attained represent in ingenious combination all the most important features of modern marine engines that experience has shown to be worthy of adoption. We sincerely hope that an enterprise started under most prosperous auspices will be thoroughly successful, and, by being so, lead to the extension of the principle of government subsidy to our trade, for such subsidies appear necessary so long as other nations employ the means that they are employing in order to paralyse our shipping industries.

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The Disappearance of the Cable Car.

LAST month saw the end of a system of locomotion in New York City that at one time was believed in the United States to be the tramway system of the future. In this country the "cable system" has, with the exception of the Edinburgh system, remained practically unknown, and was represented by such isolated and unimportant specimens as the line which is used in London to facilitate the ascent of Highgate Hill. But in the United States it formed one of the most delightful means of travelling, especially in towns in which the roads climb up and down the hills with long and steep gradients, which are in most cases the outward signs and symbols of a picturesque situation. The fullest development the cable system received was probably in San Francisco, where it was inaugurated some twenty-five years ago, and where some years since more than twenty-four miles of double-line track were in operation. Nobody who has ever visited that beautiful town will forget his rides on the cable-cars, especially in summer-time, when gliding along the smooth track at an exhilarating speed and without the slighest jar, he was able to enjoy on his right and left many a charming bit of scenery. But it was not only in San Francisco that the cable car monopolised an important portion of urban and suburban traffic. Chicago also had laid down a goodly number of miles of cable-line for the convenience and comfort of its inhabitants, not to mention a great many of the smaller towns; and soon also New York, though possessing already electric-trolley lines, followed suit, starting with the once very popular Broadway line. For many years the electric lines were looked upon with suspicion by the people of the American metropolis, while the cable lines were held by many to represent the very best form of traction in neighbourhoods of heavy traffic; and this opinion was as late as 1897 not only met with among the general public, but even among experts in tramway matters. Gradually, however, electricity as a motive power conquered the field; and the cable has, so far as New York is concerned, ceased to exist, and will live henceforth only in the memory of those who worship what they call "the good old time."

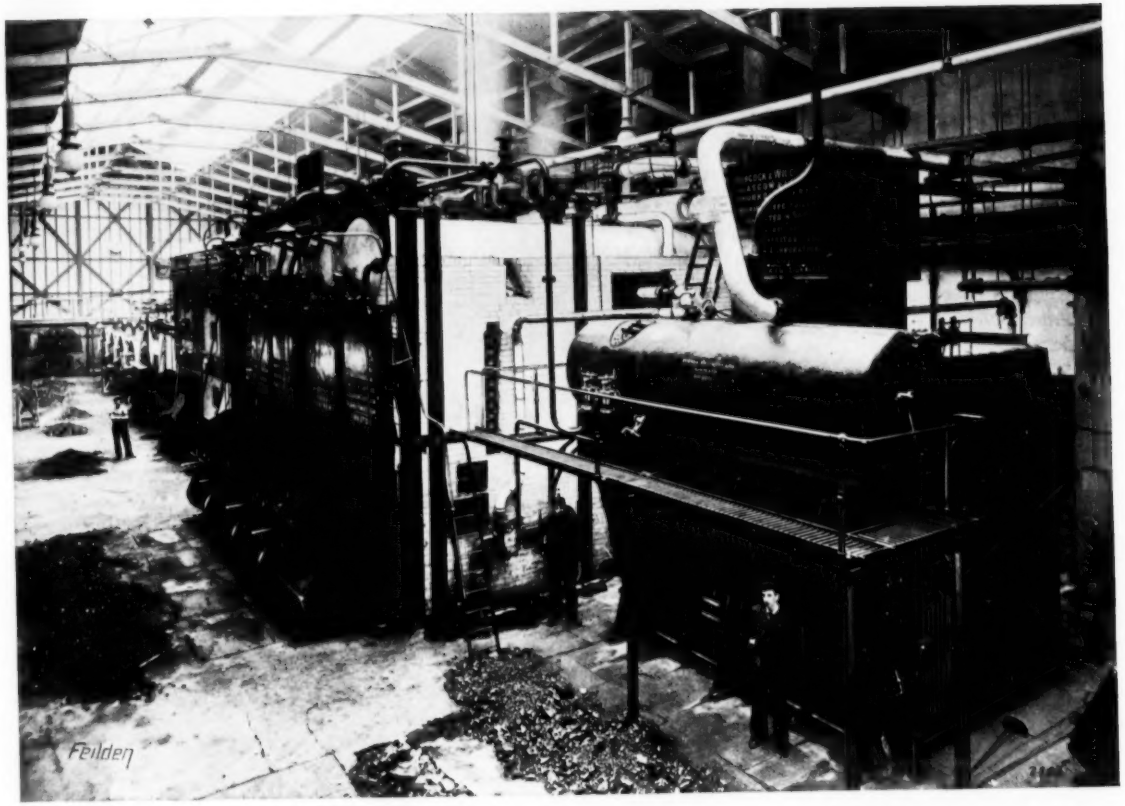
Electric Wiring Rules and Standardisation.

Two interesting papers on electric wiring rules have recently been read at meetings of local sections of the Institution of Electrical Engineers, one by Mr. G. A. Clark in April at Glasgow, and the other by Mr. F. Broadbent in February at Newcastle. In both of them the impossibility is dwelt upon of any standardisation of electrical accessories so long as the present chaos of wiring rules remains. Mr. Broadbent reminded his hearers that it was more than two years since, after the reading and discussion of three papers on this subject, the following resolution was unanimously and enthusiastically carried:

"That this meeting is of opinion that the Institution should take such steps as it thinks best to secure uniformity in rules, by pressing on supply companies, municipal engineers, and fire offices the advantages of adopting rules to be drawn up by the Institution, based on the present ones as a standard with such modifications as local conditions may necessitate."

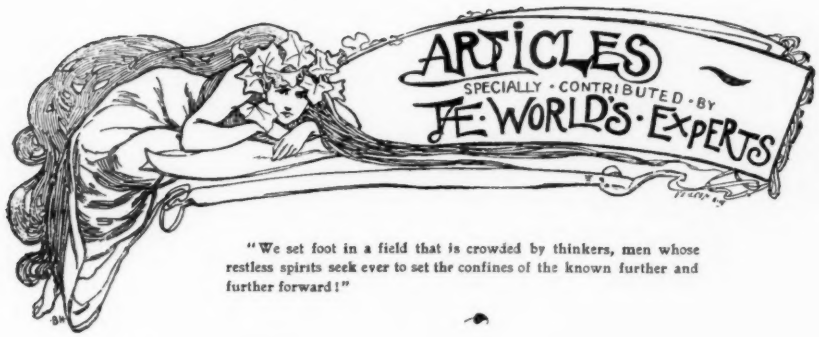
Since then nothing has been done and the confusion continues to increase, to the despair of the contractor and the detriment of the consumer. There are two things to be done. First to draw up a consistent, clearly-worded and practical set of rules, and very few of the many now in use even approximately fulfil these conditions; and second to make them universally compulsory. There should be no difficulty in forming a committee of members of the Institution who would be thoroughly competent to draw up a satisfactory set of rules; and if the rules so drawn up were then considered by a joint committee of members of the Institution and representatives of the Fire Insurance Companies, it should not be impossible to first unify and then satisfy the demands of the latter. If a set of rules were drawn up in this manner there can hardly be a doubt that the Board of Trade would be willing to give their official imprimatur and include them in their electric-lighting regulations.

XUM



THE BOILER HOUSE AT THE GLASGOW EXHIBITION.

See page 248.



"We set foot in a field that is crowded by thinkers, men whose restless spirits seek ever to set the confines of the known further and further forward!"

Argentina

Being an account of the development of her trade and industries as the result of British enterprise and capital.

By LEWIS LONGFIELD, C.E.

❀ ❀ ❀

In the year 1516, the River Plate was discovered by Diaz de Solis, a Spanish explorer, who met his death at the hands of the native Indians, being subsequently eaten with those who had landed with him. It was not until seven years later that a European settlement was successfully established in the newly-found country by Gaboto, who named the great river "Rio de la Plata," or "Silver River," "from the abundance of precious metals he procured from the inhabitants, imagining them to be the produce of the country, though, in reality, they were brought from Peru."

In 1535, the settlement of Santa Maria de Buenos Aires was founded by Del Campo, but, owing to the hostility of the Indians and other causes, it was not firmly established until 1580, when the well-directed energies of Garay succeeded in securing it against external attacks, under the name of "City of the most Holy Trinity; Port of St. Mary of Buenos Aires." From that date the settlement began to prosper, many fresh colonists arriving from Spain, and bringing with them troops of horses and cattle, which throve and multiplied, and many of which, gaining their freedom, scattered over the fertile Pampas which became their home.

Although a civilised Power had planted itself firmly on the banks of the River Plate, the growth of commerce was stunted by the foolish restrictions of Spanish rule, which endeavoured to prevent all nations other than Spain herself from trading with the newly opened country. This abuse of power was especially unjust towards those who had been encouraged to leave their homes and colonise the new possession. In 1602, however, the hardy settlers obtained permission to export two shiploads of produce yearly, but, in order to prevent internal trade with Peru, a custom-house was established at Cordoba for the purpose of levying a duty of 50 per cent. upon all goods passing to and from the River Plate. This sort of thing could not last, and, the repeated remonstrances of the people at last taking effect, in 1665 the absurd and ruinous restrictions were somewhat relaxed, although it was not until 1774 that a so-called Free Trade, with many limitations, was permitted between several American ports; from that date glowing accounts of the wealth of the country reached and were circu-

See page 238.

XUM

FIG. 1.—GENERAL ROCA.
President of the Argentine Republic.

lated over the United Kingdom. Guthrie, in his "Geographical Dictionary," published in 1781, speaks in such extravagant terms of the River Plate, that we cannot wonder at the tide of emigration which commenced to flow, from Ireland firstly, to the Silver River, in spite of the dangers and difficulties with which the long and tedious journey was beset. Imprimis, he tells us that the fertility of the soil is such that it "produces the greatest plenty of whatever is committed to it;" again, that cattle abounded in freedom in such numbers "that it is said that the hides of the beasts are all that is properly bought, the carcase being in a manner given into the bargain"! and, letting his imagination get the better of his veracity, he speaks of wonderful fish and fruits of the "paradisiacal" situation of the city (which he tells us was "of considerable extent, containing some 3,000 houses"),* and of the excellence of the climate; information which experience teaches us to reject to-day, but which was doubtless calculated to serve its end in calling up the spirit of enterprise, and in drawing out the adventurous Britisher to pastures new. Further, he tells us that, although merchants from all parts of the world plied their business in Buenos Aires, "two, or at most three, register ships make the whole of the regular intercourse with Europe; their returns are most valuable, consisting of the gold and silver of Chile and Peru, sugar and hides;" and he adds the quaint piece of legitimate (?) information, that "Those who have now and then carried on a contraband trade to this city have found it more advantageous than any other whatever"!

The "Encyclopædia Britannica" of 1790 corroborates most of Guthrie's statements, but, from many absurd and false assertions, it is evident that the authors of both the articles were writing entirely from hearsay.

The "E. B." tells us that "no country in the world abounds more in horned cattle and horses than Buenos Aires, where the greatest expense of a horse or a cow is in the catching of it."

Little wonder, then, that England, who was cutting her teeth of Empire, should have looked longingly towards this land of marvels, and that, when the war with Spain gave the desired opportunity, she should have sent a powerful expedition under Popham and Beresford to fly the British flag over the River Plate. We know the sad tale of victory, followed by the defeat of "Whitefeather" Whitelock, whose blunders, intentional or otherwise, lost to England what would now have been one of the gems of her Empire, and effectually retarded the march of civilisation and of commerce in Buenos Aires for at least half a century.

The defeat of British arms, which was in no way due to the valour of the Spanish soldiery, who fled in panic upon our landing, but to the insane orders of the British general and to a general rising of civil an and peasant against our invading forces, resulted in the War of Independence, wherein the Spanish yoke was eventually thrown off by every colony and settlement, and whereby Spanish rule in South America became in 1824 a dead letter.

The loss of Argentina alone deprived Spain of 1,212,000 square miles of her richest territory.

* The most recent figures show a population of nearly 800,000.

In 1825 a National Constitution for the federal States which now form Argentina was decreed, and in the same year a commercial treaty with Great Britain was signed.

Immigration was encouraged by the offers of extensive grants of land to all new comers, which were in no way conditional upon their position or property. Many Irishmen availed themselves of these opportunities, and though they landed at Buenos Aires with little more in their possession than the clothes in which they stood, they were soon on the way to prosperity and wealth, as the position of their descendants to-day amply testifies. In 1864 12,000 Irishmen had acquired settlements in Argentina.

The growing immigration naturally opened up new industries, and was a chief factor in the country's development, which however was sadly stunted by the unceasing civil wars that characterised the first forty years of the Independence, and which continued intermittently until the formation of the Republic in 1861.

The introduction of steam as a motive power was destined to conquer the almost insuperable difficulties with which the illimitable Pampas obstructed internal development; for, stone of any kind being almost entirely unknown in these great plains, there are, even to-day, no roads worthy of the name.

In 1857 the first railway was opened, proving to be the pioneer of the many extensive systems which every year are developing more and more of the country's great resources.

In 1863 the first sod of the Central Argentine Railway was turned, and in 1870 the line was opened for traffic between Rosario and Cordoba, the distance covered being 246 miles; the result was that the wilderness, peopled by marauding Indians, was conquered, and that towns and colonies sprang at once into being. It was British enterprise that achieved these wonders.

FIG. 2.—BUENOS AIRES RIVER FRONTAGE IN 1885, SHOWING PASSENGER AND CUSTOM HOUSE MOLES.

Other companies followed suit, and the extension of the railway network in Argentina is clearly shown by the following table :—

RAILWAYS MILES OPEN.			
1862	1873	1883	1886
631	1,409	1,638	4,150
1889	1892	1897	1900
6,940	7,676	9,270	10,595

The most important of the railway systems is the Great Southern Railway, which has some 2,000 miles open to traffic, and which is sending out its arms all over the southern provinces.

The many other great British railway systems are, almost without exception, flourishing and growing concerns, in nearly every case British management having been the passport to success.

The long and uncertain voyages of brig and schooner were soon to become obsolete in nearly every branch of commerce, and, in 1871, the steamers arriving at and clearing Buenos Aires exceeded the sailing vessels in tonnage.

The Royal Mail Steam Packet Company was the first to commence a regular steamship service with South America, the

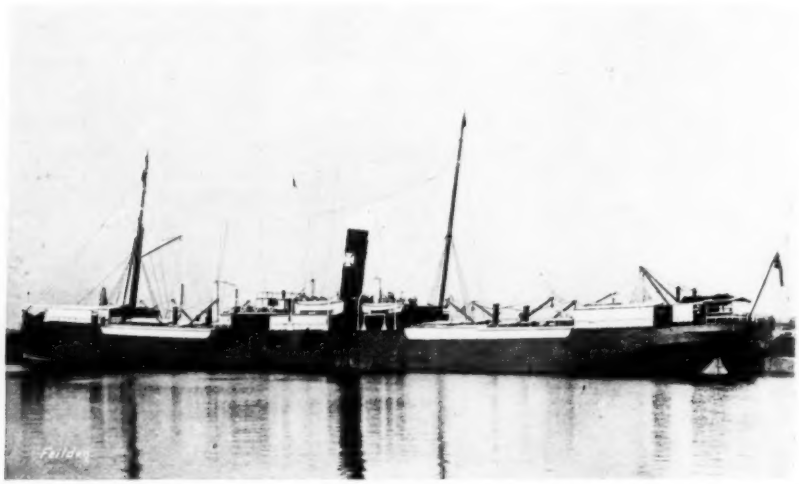


FIG. 3.—HOULDER LINER, SS. "SOUTHERN CROSS," SPECIALLY DESIGNED FOR RIVER PLATE CATTLE TRADE. 1,350 TONS DEAD-WEIGHT CAPACITY.

The flatness of the country, which this railway traverses for many hundreds of miles, presents many exceptional advantages for goods traffic, as may be gathered from the fact that the standard goods train consists of 180 axles, the average load being about 6 tons per axle, which standard is often exceeded, the writer being informed by Mr. Robert Gould, the courteous locomotive superintendent of the railway, that he has travelled on a train of stone having 192 axles, with a total load of over 1,400 tons, the length of the train being nearly half-a-mile.

first vessel sailing in 1851 to Rio, where, until 1869, the main line steamers stopped; passengers, mails, and cargo being transferred to a small coasting vessel, which ran between Brazil and Argentina. In 1869 the first direct line to the River Plate was started by the same company, one steamer per month being sufficient until 1872, when the service was doubled.

The first and perhaps the chief result of steam communication was that immigration increased by leaps and bounds. From 1872 to 1879 the influx of foreigners

was over 2,000,000, more than 50 per cent. being Italian. The excess of immigration over emigration during the 20 years from 1871 to 1891 approximated 1,135,000.

Telegraphic communication with Europe was established in 1874, the internal telegraphic system growing with the railways. In 1871 there were 1,230 miles of telegraph open, compared with 27,584 miles (with 58,656 miles of wires) in 1900.

It was England who first perceived the immense commercial possibilities which Argentina presented, and it was English energy and capital which stirred the country into life, showing themselves in railways, docks, gas companies, tramways, electric lighting, and, in fact, in all the modern improvements that are necessary factors in a country's prosperity.

One great drawback to the commercial

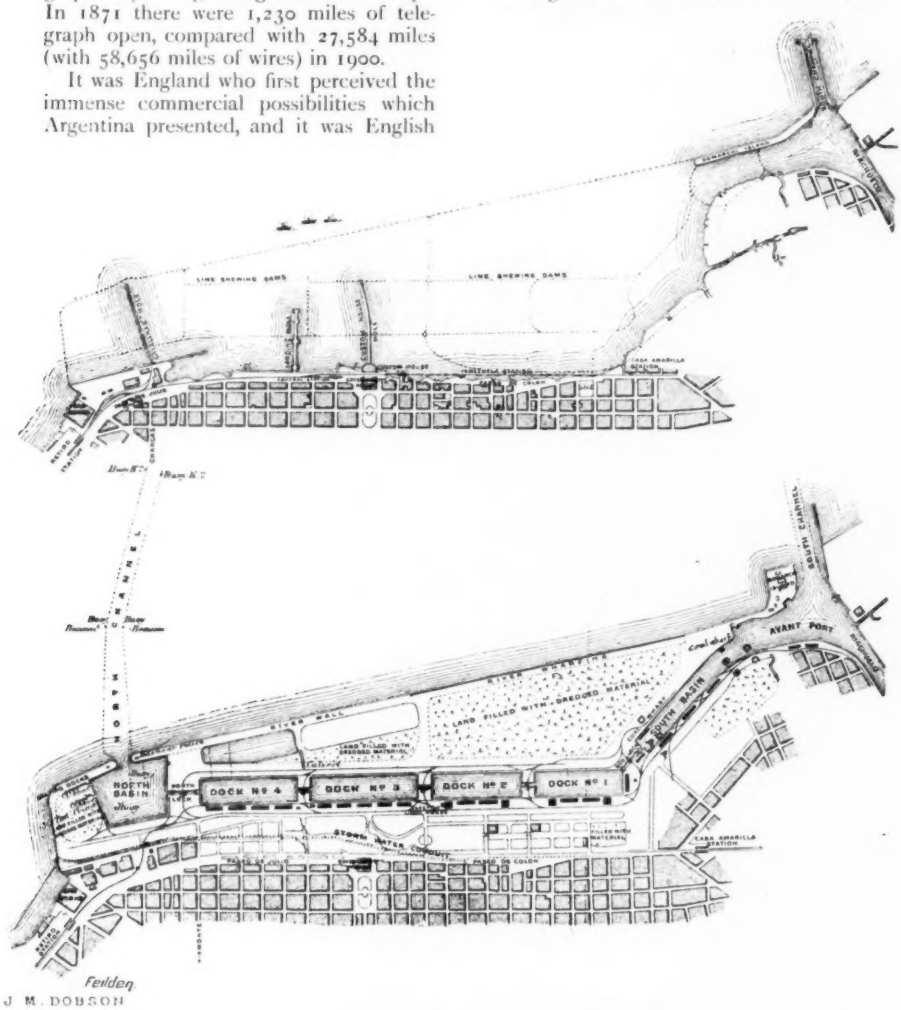


FIG. 4.—PLANS SHOWING FORESHORE OF BUENOS AIRES CITY IN 1885, AND AFTER COMPLETION OF HARBOUR WORKS IN 1893. DOCK, 3,690 MÈTRES LONG, WILL SHOW THE SCALE.

welfare of Argentina was, and still is to a certain extent, the situation of Buenos Aires, the capital town and chief port, which lies upon the bank of the River Plate, some 100 miles above the river's mouth; for the shallow nature of the Plate, its shifting banks and uncertain tides, are all serious obstacles to facile navigation. Less than 15 years ago there existed no dock in the whole of Argentina, and passengers landing at Buenos Aires had an eventful and exciting time before reaching their journey's end. Firstly, they were embarked upon a tender, which, if

along the city front, and which for many years were known by his name. In 1862 Señor Madero first saw the necessity of docks for the city, but it was not until 20 years later that his repeated applications for a concession for their construction were successful.

In 1884 the firm of Sir John Hawkshaw, Son & Hayter, who had been chosen to design the work, made their report to Mr. Madero, which was approved of; and a contract being entered into between Mr. Madero and the late Mr. T. A. Walker, the work was immediately com-

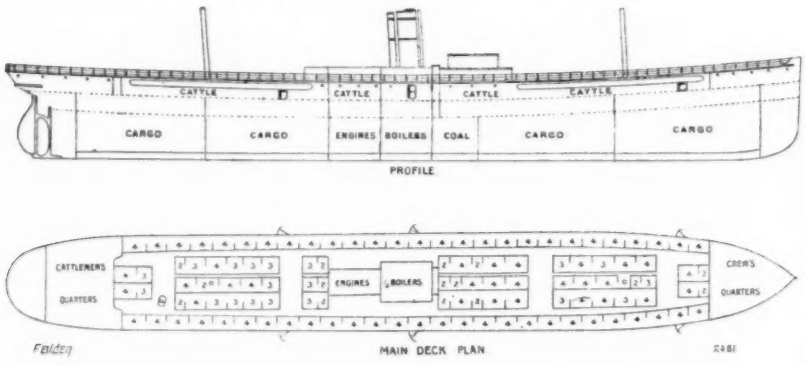


FIG. 5.—SECTION AND PLAN OF MESSRS. LAMPORT AND HOLT'S STEAMERS "REMBRANDT," "RAPHAEL" AND "ROMNEY," SHOWING CATTLE SPACE. 5,500 TONS DEAD-WEIGHT CAPACITY; SPECIALLY DESIGNED FOR THE ARGENTINE CATTLE TRADE.

the tide was low, took them to within a mile or so of the shore, where they had to change into a boat of shallower draught, which carried them as far as it could without running aground; and from this they were lifted into a huge-wheeled bullock-cart, which bore them, with many splashings and joltings, to terra-firma.

When it is said that there was but this method in vogue for both passengers and cargo, it will be readily understood that the landing and loading of freight was no easy matter. To Don Eduardo Madero belongs the honour of having, by dint of perseverance, overcome the foolish scruples of short-sighted conservatism, and opened a wide door for Argentine trade by means of the splendid docks which to-day lie all

menced. We can but take a cursory glance at these great works, which have already helped so much in Argentine commercial development. The quay length of the docks is 6,600 yds., and the storage capacity of the sheds and warehouses is some 687,380 cub. yds. There is a complete system of hydraulic cranes and machinery throughout the works, and the name of Armstrong, Mitchell & Co., who contracted for this important branch of the work, is a sufficient guarantee of its excellence.

The area of land reclaimed from the river is 926 acres, of which 164 acres are available for sale. In 1888 two offers were made for this land; the first was an offer of £4,000,000 from Mr. Madero,

while the second of £4,500,000 came from an English company. The Government, however, preferred the birds in the bush, which have not been caught yet! The total cost of this work was £7,068,814, so that, had the second offer been accepted, the four docks, basins, graving docks, etc., would have only cost the Government £2,068,814!

Simultaneously with the opening of the first section of the docks, a dock at La Plata was opened which had been built under Dutch supervision. It is a small but important work, and up till quite recently all the bigger passenger steamers have gone there because of its greater depth of water. Now, however, that the "north channel" (which is 100 mètres wide, with a depth of 21 ft. at low water) to the Buenos Aires docks has been completed, it is to be hoped that passengers will no longer be put to the trouble of having to go a tiresome railway journey before reaching the steamer, when there are much more convenient and capacious docks within a stone's throw of the city front.

Of recent years there has been a marked tendency to increase the size of ocean-going steamers, and it must be borne in mind that not one of Messrs. Harland & Wolff's leviathans could possibly steam up the River Plate. If, then, the building of these great ships should find general favour, it is evident that Argentina will have to establish her chief port elsewhere than at Buenos Aires.

The Great Southern Railway, however, does not anticipate any immediate likelihood of a universal adoption of the recent innovation in ship-building, for the Railway is building a fine dock for itself within a short distance of the southern end of the Buenos Aires Docks; Messrs. C. H. Walker & Co. being the contractors.

An important shipping centre is Rosario de Santa Fé, where there exists a flourishing British colony, and whose chief trade is in

FIG. 6.—CATTLE FITTINGS: HOULDER LINE OF STEAMERS.

the export of corn and cereals. Rosario, being further up the river than Buenos Aires, labours under still greater difficulties than the capital city.

The port of Bahia Blanca, which lies more than 400 mls. south of Buenos Aires, is a deep-water harbour of great present importance, and it is more than likely that at some future date it may become the chief harbour in the Argentine Republic.

The Southern Railway, which is rapidly extending over the Southern provinces, may be said to have given birth to this port, for all the produce of the Southern Pampas will find an outlet here.

Signor Luiggi, an eminent Italian engineer, has designed a military harbour here, the contract for the work having been given to a Dutch firm. The increase of shipping arriving at and clearing Argentine ports is demonstrated by the following figures :—

TONNAGE.

1866	514,951	1891	4,673,847
1886	3,153,389	1895	6,247,101
1887	3,273,969	1896	7,115,467
1888	4,319,439	1897	6,064,064
1889	5,842,972	1898	6,555,128
1890	5,506,469	1899	6,939,567

It will be seen that the tonnage of '96 exceeded that of '86 by nearly 4,000,000 tons ; a tremendous increase ! Between 30 and 40 per cent. of the yearly totals were under the British flag ; in '90 fully 40 per cent. being British, and in '95 the tonnage of British vessels amounting to 1,634,504 tons. The chief exports to Great Britain are wheat, wool, skins, tallow, hides, beef, mutton, linseed, maize, bones, and live-stock.

A table of exports and imports to and from Great Britain from 1860 is appended.

TRADE WITH GREAT BRITAIN.

Year.	Exports.	Imports.
1860	£1,097,755	£1,782,447
1870	1,486,425	2,346,937
1880	886,628	2,450,576
1885	1,878,921	4,660,460
1890	4,129,802	8,416,112
1895	9,084,497	5,349,091
1896	8,974,164	6,620,993
1897	5,753,916	4,801,125
1898	7,788,332	5,586,276
1899	10,942,349	6,210,729

In 1894 the value of wheat exported to Great Britain was £3,400,954, whereas in 1897 it fell to £318,871, the lowest figure for many years, while the quantity exported in 1899 reached 1,713,429 tons, or seventeen times the amount exported two years previously. What seems likely to prove one of Argentina's most important exports is that of live stock, which is almost monopolised by Great Britain. Beginning in 1885, it has already developed wonderfully, as the appended table will show.

HEAD OF CATTLE AND SHEEP LANDED AT DEPTFORD AND LIVERPOOL.

Year.	Cattle.	Sheep.
1885	—	100
1889	19	—
1890	554	20,359
1891	3,929	19,082
1892	3,405	13,165
1893	6,885	22,362
1894	9,554	73,518
1895	39,187	305,355
1896	66,742	341,360
1897	73,424	349,220
1898	89,587	431,074
1899	85,365	382,080
1900	38,562	178,969

The recent falling-off being due to the abnormal condition of things caused by the spread of foot and mouth disease and the terrible floods and rains of two years ago.

There are already twelve British shipping companies engaged in this trade, which is increasing every year. The more powerful companies, realising the importance of the trade, are already providing specially-built steamers, adapted for the traffic of cattle, and arranged upon humane principles to prevent the wholesale maiming of the beasts, and frequently the loss of a large portion of the living freight through stress of weather, which so frequently occurred under the old conditions. The steamers of Messrs. Houlder Bros. have been specially designed for this trade, as the accompanying illustrations will show. Messrs. Lamport & Holt have also several steamers, which have been built to meet all the new requirements, and it is to be hoped that we shall soon hear no more of the terrible havoc which a storm at sea has always wrought hitherto.

England has consumed 49,747,843 carcases of mutton and lamb in the last 19 years, of which 17,490,769 carcases have come from the Argentine, the Houlder Line alone carrying—

Year.	Carcases sheep.	Carcases lamb.	Quarters beef.
1897	509,005	5,415	12,977
1898	610,317	5,099	29,339

Seeing that the first shipment of Argentine frozen meat was made in 1883, it will be seen that this trade has already taken great strides. Here again we find an English company taking the place of pioneer as in almost every other important trade.

The vast extent of the country and its enormous possibilities will be better understood when it is stated that in 1891 there were 7,400,000 acres under cultivation, which showed an increase of $1\frac{1}{2}$ millions since 1888, and that this great tract of land barely represented a hundredth part of the total area of the country; whereas in 1895 the number of acres under cultivation had risen to 15,000,000, or about a sixteenth of the area available for agricultural purposes.

England may well be proud of the great British banking institutions, headed by the London and River Plate Bank, which nearly forty years ago began its life with the modest capital of £600,000, and which has since grown into a vast and wealthy establishment, whose funds may to-day be roughly summed up thus: Authorised capital, £1,500,000; paid up, £900,000; reserve fund, £1,000,000; whereas the share, which forty years ago cost £15, is worth £52 to-day.

There are two other large and influential British banking houses, whose pros-

FIG. 7.—THE MOUTH OF THE RIACHUELO—UNTIL 1885 THE SOLE PORT OF BUENOS AIRES CITY—SHOWING DEMARCHI ISLAND AND PIER IN BACKGROUND.

perity attests to their excellent management.

The sad story of the National Banks needs no repetition. It goes hand in hand with the National Railways, and may be summed up under the headings of Corruption and Mismanagement.

Besides these great British houses, without which Argentine prosperity were non-existent, there are other important British institutions, chief among which comes the River Plate Trust Loan Agency, with a subscribed capital of $1\frac{3}{4}$ millions, and which paid $13\frac{1}{2}$ per cent. last dividend.

It is estimated that the total amount of foreign capital invested directly or indirectly in Argentina almost reaches the figure of a hundred and twenty-three millions, of which the greater part is British.

England was called upon to supply the first of many loans in 1827 at the low interest of 3 per cent., which shows that British capitalists of 70 years ago understood the capabilities of the country but not of the people!

Out of proportion to the growth of commerce and revenue has been the growth of the National Debt, a fact borne out by the following figures: Total debt, external and internal, 1827, £1,000,000; 1867, £6,496,742; 1878, £21,468,200; 1887, £55,000,000; 1897, £86,635,680; while in 1900 the external debt alone had swelled to the sum of £87,575,500, thus constituting a heavy drainage upon the yearly income. Besides this debt, the provincial Governments have taken advantage of a prosperous moment to secure money at the expense of British investors, as these latter know to their cost, and in 1895 the Provincial Debt amounted to £35,589,900. It is to be hoped that the unification scheme now being carried out will have a satisfactory issue. By this scheme the National Government has taken over the Provincial Debt, and has issued $4\frac{1}{2}$ per cent. bonds in exchange. It is, however, impossible within the limits of this article to discuss this important step, however superficially. The Provincial Governments are hotbeds of corruption; nor can Argentina be truly said to prosper until they are rooted out, for they are a source of continual sappage of the country's vital forces in that they foster the germs of revolution, so dear to the peasant half-breed, which the central Government has successfully eradicated. Provincial officialism is a passport to robbery, and even in the last year or so has a high provincial dignitary been ejected from his position at the muzzle of a revolver. Provincial law is the essence of lawlessness, the thief or murderer plying his trade with scant molestation.

We may safely say that the great increase in Argentine revenues is due to British energy and capital, for were all our capital to be withdrawn, and the living and working results of our energies to vanish, we would find Argentina but a half-civilised country, stripped of all the essentials of prosperity and development.

The sugar industry, towards the development of which British energy has greatly helped, has a great future before it. Although there has been a falling off in the amount turned out yearly since 1896, we may soon expect to see the output increase. In 1896 some 119,000 tons were manufactured, as compared with 60,000 tons in 1898.

In almost every trade we find the lead taken by British firms, and we sincerely hope to see the lead maintained.

The importation of agricultural machinery is a large and material branch of trade, and although there are many British houses which import British-made goods, the increase of German and American goods becomes more noticeable every year. The American company touts for its wares through energetic travellers, whose capabilities of advertising and pushful methods are full of result. The German exhibits every class of machinery in large and magnificent show-rooms specially designed to attract, whereas the Britisher sticks to the old uninviting premises, greatly to the detriment of his business.

In the manufacture of furniture and in the sartorial line British firms are *facile princepes;* but here, as elsewhere, notwithstanding the heavy duties and high wages to be paid, the charges are exorbitant. The British business-house knows

that it sells better articles than can be obtained from any other, and fixes its price accordingly, so that those who will not put up with the inferior article have to pay the higher figure.

The drainage system of Buenos Aires, which was carried out under English engineers, has proved effectual in preventing the recurrence of epidemic, such as the plague of 1871, which decimated the population and demoralised for the time not only the city trade but also that of the whole country.

Hitherto, in most questions of engineering, English advice has been at a premium; but we cannot expect this to be always so, for the Argentine is slowing and steadying down in nature; moreover, he is quick-witted, possessing at the same time great natural abilities, besides which he does not under-estimate his powers. Were the capitalists confident in him as he is in himself, we should find him to-day managing and directing most of his own affairs, like the Japanese. In lesser matters we see this most clearly defined, for in the navy, wherein up till quite recently Scotch and Englishmen held every engineering post, we find their native subordinates, who have learnt their lesson quickly and with intelligence, gradually occupying the shoes of their predecessors. It is only natural that this should be so, for the English mechanic or skilled labourer is invariably an expensive luxury. There are, however, many virgin fields which need but the influence of capital and will to yield their concealed treasures.

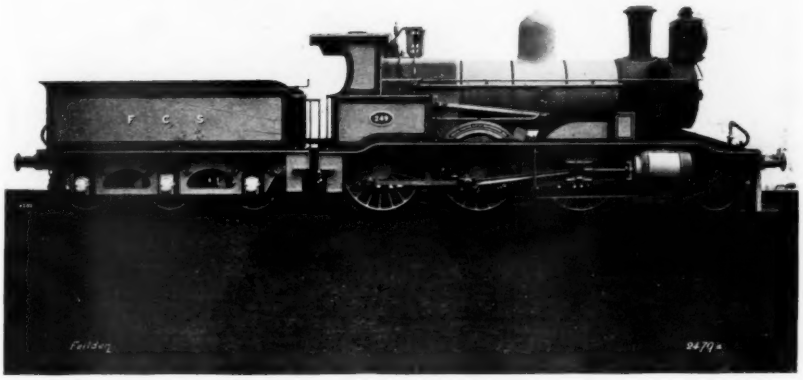


FIG. 8.—RECENT TYPE OF GOODS-ENGINE BUILT BY MESSRS. BEYER AND PEACOCK FOR THE GREAT SOUTHERN RAILWAY.

The country is rich in minerals: coal (lignite), lead, silver, gold, petroleum, salt, onyx, and others of value being found in many parts of the Republic. Large forests of the most valuable hardwoods run down to the river's edge some few hundred miles above Buenos Aires, and yet, although the wood is frequently in great demand for piling, wharfing, sleepers, etc., it has been found to be cheapest and easiest to

procure Jarrah and Karri wood from New Zealand when large quantities are required.

At present the wealth of Argentina lies in her agriculture, and before long we should see "Lucerne" and fruits among her important exports. To ensure agricultural prosperity the ravages of insect and locust must be prevented, and it is good to see English names among the foremost of those who have set on foot the vigorous movement for combating these plagues. Experience will teach the remedy. Again, Argentine butter is universally admitted to be of the finest quality, and, from the cheapness of its production, it will soon form an important item in the export list.

All that is now needed to open out Argentina is steady energy, backed by steady capital. Prosperity has twice proved her worst enemy, for with its advent both energy and capital went mad, and the whole country became a Bedlam of speculators. The result was a crash which taught a bitter lesson both to the impulsive Argentine and to the speculating foreigner, whose money had vanished into nothing.

We have, by dint of perseverance, instilled much of our proverbial steadiness into the changeable Argentine nature. We have helped to make the country what it is to-day, and we have proved ourselves, by our slow but sure methods, to be the great organisers of the world.

The writer would deem this article incomplete without special reference to General Roca, whose portrait is reproduced on p. 210. He is the mainspring of Argentine progress, a man of adamantine will, who will brook of no interference with his plans and projects. He has defied the Romish See, and, seeing, perhaps, that true liberty is the key to prosperity, he has been instrumental in bringing about a law whereby the Bible is now taught all over the Republic. He is the Englishman's friend in that he is the advocate of expansion and development; and, seeing that British gold and brains are safest and surest, he has employed them extensively. Finally, we may say that, although his ideas are somewhat too ambitious and advanced for his country, which is but now struggling to stand on its own legs, he is the strong man whose purposes none may even try or wish to thwart with impunity; in fact, he is the very man who is needed at the helm of the ship of Argentine affairs.

We have striven to show how Great Britain and Ireland have influenced the trade and progress of industries in the River Plate. Great trust has been placed in us, and, speaking broadly, we have shown ourselves worthy of it. Now there lie many fresh fields open to all comers, in which, as elsewhere, we must show our traditional capabilities, and maintain the lead which in almost every branch of trade we have taken.

The author wishes to acknowledge the kind permission of the Institution of Civil Engineers for the reproduction of the plan of Buenos Aires Port appearing on page 213.

Lewis Longfield

The Town Refuse Problem and its Relation to Steam Production.

By WILLIAM H. MAXWELL, Assoc.M.Inst.C.E.

(*Continued from page 663, Vol. IV.*)

WILKIE'S IMPROVEMENTS IN BEAMAN & DEAS' PATENTS.

Messrs. Meldrum Bros., Engineers, Manchester, have recently patented important modifications, described as "Wilkie's Improvements," in the original Beaman & Deas' furnace, which embody all the essential features incidental to the Beaman & Deas System, but at the same time involve changes of construction so radical as to constitute practically a new design of furnace.

Briefly summarised, the principal objects aimed at by the improvements are as follows :—

(*a*) To obtain a more perfect combustion of the articles and substances treated.

(*b*) To economise space and thereby reduce cost.

(*c*) To more fully utilise the heat generated in the process of combustion.

(*d*) To provide means for charging the fuel or refuse to the hearths without handling.

These improvements are effected, as will be seen from Fig. 15, by arranging the fire-bridges in juxtaposition, *i.e.*, two of the furnaces or cells are placed end to end at their fire-bridge ends, sufficient space being left between their respective bridges to form a combustion chamber. Thus, the particles forming the gases or products of combustion impinge direct on one another, ensuring their more thorough admixture and fusion.

The temperature in the combustion chamber is proportionately raised, and more heat is available for steam generating purposes. The boiler is placed immediately adjacent to the combustion chamber, so that radiation losses are reduced to a minimum.

Means of isolating a pair of cells from its steam generator can be introduced if desired, and the cells can be extended indefinitely in single or parallel series without any intervening space between the units.

The storage and charging apparatus consists of two hoppers, one above the other, the upper being adapted to have the contents of the cart tipped directly into it, and being also provided, when necessary, with a screen or grid, to prevent the more bulky articles from passing to the lower hopper. Between the two are doors, which can be operated in any suitable manner other than that indicated in the plans. The function of the lower hopper is simply to regulate the quantity of refuse that will fall on to the hearth, and to prevent too much being delivered at one time. Its capacity approximates to one cubic yard, and it also is furnished with suitable doors.

The hoppers are wholly supported by joists or girders in the upper or tipping platform, and the brickwork in the furnace is left entirely free to expand or contract.

Fig. 16 is a plan of the furnaces arranged in parallel series, one-half being shown in plan and the other in section above the grate level. The following references describe the principal parts of the plant :

A A'. Refuse furnaces, or cells, with feed hopper, discharging over flat hearth, slightly raised above grate level.

B B'. Fire-bridges on either side of combustion chamber.

C C. Combustion chambers between fire-bridges.

D. Dampers.

E. Boilers.

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F. Main flue under ground.
G. Inlet into main flue.
H. Opening to boiler.
J. Combustion chamber bottom.
L. Hoppers.
N. Hopper door.

The normal working capacity of the plant given in the accompanying figure is estimated to be 120 tons of refuse per day of twenty-four hours, or about 11,200 lbs. per hour, and in times of pressure it is believed that 160 tons can be dealt with in that period.

Assuming that 1 lb. of refuse will evaporate from 1 lb. to 1·5 lbs. of water, the steam-producing capacity of this plant will range from 11,200 lbs. to 16,800 lbs. per hour on the 120 tons per diem basis, or from 560 to 840 i.h.p. per hour.

THE HEENAN TWIN-CELL DESTRUCTOR.

An experimental Heenan twin-cell destructor has been in use for some time at Farnworth, erected by Messrs. Heenan & Froude. This furnace is dealing with the whole of the town refuse, and also is raising steam.

Since its inception some three years ago this type of destructor has undergone some modifications, each of which adds to its efficiency. The modifications are as follows:—

1. The omission of the overthrow damper, and the replacing same by a simple deflecting and reverbatory arch, which fulfils the object of the former, conserves heat, and is indestructible.

2. Method of charging is slightly altered, and is so arranged that no men are required on the charging platform, except to sweep up occasionally; and sealed storage is provided to each cell, with a capacity of ¾ to 1 day supply.

3. Ventilation-fans for producing the draught are invariably placed on the tipping platform at the opposite end to the entrance, and thus draw their supply from the building.

4. Method of staying and bracing is much improved, there being absolutely no rupturing of the brickwork.

5. By arrangement with Messrs. J. Howden & Co., Glasgow, Howden's system of forced draught has been adopted, by which means more perfect combustion is obtained, and by means of the air-heater or regenerator the temperature of the waste gases is reduced to about 200 deg. Fahr., with the result that the temperature in the combustion-chamber is greatly increased and maintained.

6. By a simple automatic arrangement no cold air can enter the furnaces during charging or clinkering.

7. More ready adaptability than formerly for working in conjunction with any type of boiler.

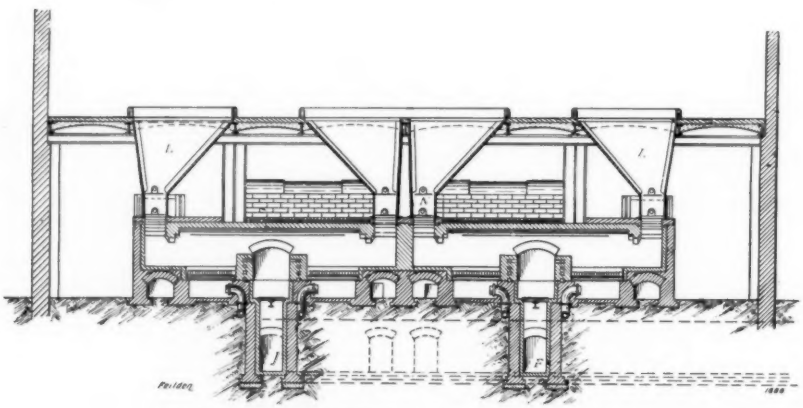

FIG. 15.—WILKIE'S IMPROVEMENTS IN BEAMAN AND DEAS' PATENTS.

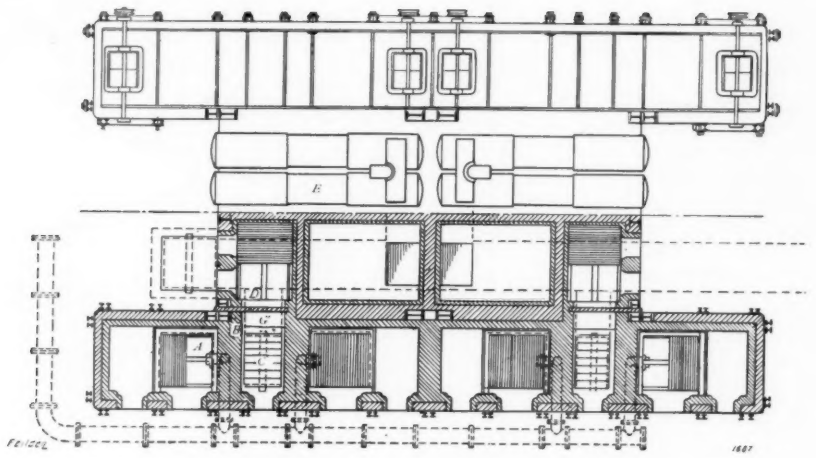

FIG. 16.—WILKIE'S IMPROVEMENTS IN BEAMAN AND DEAS' PATENTS: PLAN OF THE FURNACES.

A larger destructor of this type is being adopted by the city of Gloucester, and is illustrated by Figs. 21, 22, 23, 24. It will be seen that the cells are arranged in pairs, with arched flues over, conveying the gases to a tubular boiler fixed at a considerable height above the clinkering floor.

The refuse is fed into the furnace through an iron shoot in the rear leading down from the charging floor. The grate area is about 6 ft. 6 ins. by 6 ft., or 39 sq. ft., and this will probably deal with from 12 to 13 tons per twenty-four hours. A steam jet supplies the forced draught. After this plant has been in use for a sufficient time, and has had a fair trial, it will be interesting to compare its working and calorific results with the other types of furnaces now on the market.

Other destructors of this type in course of erection are at Northampton, Wood Green, Atherton, Rawtenstall, two in Lancashire, and one in Yorkshire. One of these is an 80-ton plant for electric traction; while another of 100 tons is to be used in connection with pumping purposes.

OTHER DESTRUCTOR SYSTEMS.

In addition to the well-known Fryer, Warner, Horsfall, Meldrum, and Beaman and Deas' systems described above, other types* of furnaces and plant have been introduced from time to time during recent years, but less extensively adopted. These include the Hanson's utiliser, Mason's gasifier, the Bennett-Phythian, Cracknell's (Melbourne), Willoughby's, Healey's improved, Coltman's (Loughborough); and also may be mentioned Whiley's destructor, patented in 1891, and erected in Manchester.

A furnace of the Bennett-Phythian type has been erected by the Farnworth Urban District Council, and the Willoughby destructor is in use at Lewisham. The furnaces of this latter type consist of long iron tubes lined with firebrick, which are continually kept revolving. The tubes are fixed with a slight inclination, and at the higher end is a cell, in which coal, coke, or other fuel is burnt, and by means of which the refuse from the tubular furnaces is kept burning.

Mason's refuse gasifier is an apparatus of a novel character, and may be seen in use in the district of the Moss Side Urban District Council, near Manchester. Instead

* For detailed particulars see "Removal and Disposal of Town Refuse and Construction of Destructor Plants," by William H. Maxwell, Assoc.M.Inst.C.E., Borough Engineer, Tunbridge Wells. Price 15s.

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of burning the gases as they are distilled from the refuse, they are carried into a combustion chamber, where they are mixed with heated air to create combustion, and a high temperature is there attained, whilst in the furnace itself the refuse is burned at a comparatively low temperature.

SHOREDITCH COMBINED DESTRUCTOR AND ELECTRIC PLANT.*

The Shoreditch combined destructor and electric plant was the first, and is still probably the largest, installation of the kind in operation, and has excited considerable interest in municipal circles. It has been working continuously since June, 1897, and the experience gained since that time has been such as to establish it as a successful undertaking upon the combined principle.

* See also "Proceedings of the Institution of Civil Engineers," vol. cxxxix., on "Combined Refuse Destructors and Power Plants," by Ch. Newton Russell, A.M.I.C.E.

The refuse destructor plant, which was built by Messrs. Manlove, Alliott & Co., consists of a battery of twelve cells arrayed side by side in two parallel rows of six each. A Babcock & Wilcox water-tube boiler is placed between each pair of cells, making six boilers in all. Each boiler, therefore, receives the gases from two cells, and, in addition, is provided with the ordinary coal-fire grate immediately under the tubes for auxiliary use when required. The disposition of the furnaces, boilers, flues, and electric plant will be seen from the accompanying diagram, Fig. 17.

The heated gases from the destructor cells pass through short side outlet flues into direct contact with the boiler-tubes, and away into the main flue which conveys them to the Economiser, after passing which they escape into the chimney-shaft adjoining.

The furnace grates of the cells are 5ft.

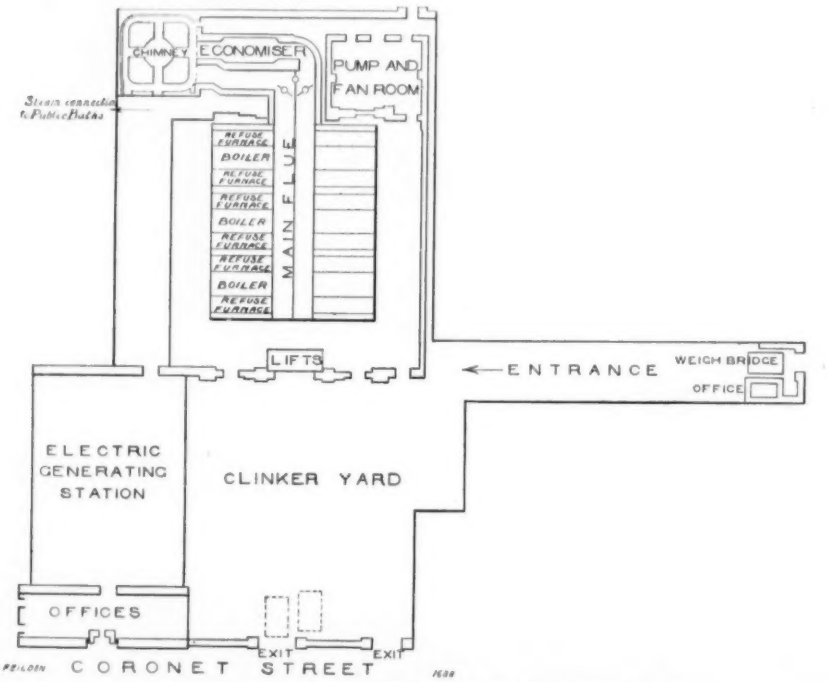

FIG. 17.—GROUND PLAN OF THE DESTRUCTOR WORKS OF THE SHOREDITCH VESTRY.

by 5 ft., and consist of stationary type bars built up of wrought iron wedge-shaped strips in sections 2 ft. 6 in. by $3\frac{1}{2}$ ins. The grate inclines at a slope of 25 deg. to the horizontal, and has a drying hearth at the back upon which the refuse first falls through the feed-opening from above. The coal-grate to each boiler is 27 sq. ft. in area, and the heating surface per boiler is 1,300 sq. ft.

There is no inclined roadway, but the refuse upon arriving into the yard, is shot into electric lifts provided with tipping trucks which run off the lift on arriving to the platform level, and tip direct into Boulnois & Brodie's special charging trucks (worked by chain gearing), one of which serves each furnace. About 84 tons of refuse per day are brought to the station, but this amount has varied up to as much as 140 tons in one day, and in order to cope with this irregular supply, a large rectangular iron storage bin is provided under the tipping platform.

FIG. 18.—SHOREDITCH DESTRUCTOR: SHOWING FRONT VIEW OF FURNACES AND BOILERS.

The operations of lifting, tipping trucks, etc., are performed by electricity, and the average amount of energy absorbed in this way is ·52 kilo-watt hours per ton, principally expended in the lifting operation. A load of refuse can be shot into the lift, raised to platform level, tipped, and the truck returned again in an average time of about nine minutes. It is important that the time thus occupied should be as short as possible, otherwise, with limited lift accommodation, the dust-carts will be kept waiting, and their time thus wasted. This difficulty is accentuated by the fact that, at destructor stations it is found from experience, that dust-carts usually arrive in batches, so that ample provision should be made for their speedy despatch.

The refuse-charging trucks, worked on the Boulnois & Brodie's system, enable the refuse to be transmitted from the dust-carts to the furnaces without handling, and are of the type to be seen in use at Liverpool, Cambridge, and elsewhere. The trucks, however, are not found suitable for charging with light refuse, as paper, straw, shavings, etc., which take fire before being safely delivered into the cells.

Three Sturtevant fans, driven direct by a shunt-wound electric motor at a speed

of some 650 revolutions per minute, deliver forced-air draught into the refuse cells. The air-blast is conveyed in the usual manner through a common duct vertically under the drying hearth of the furnace, and from which air-valves deliver into the ashpits under the grate bars. The air-pressure in the duct at the fan is 3 ins. water gauge, and in the ashpits about 1 in. only. The fans run continuously, night and day, for weeks without a stop, the works being run on eight-hour shifts

through which the boiler-feed-water is heated to about 220 degs. Fahr., and then passes on into a hot-water-feed storage vessel measuring 30 ft. long by 8 ft. diameter, and placed at a level of 20 ft. above the boilers. From this vessel, during hours of full load, the boilers are fed directly, the storage being replenished during hours of light load. The storage vessel works at the same pressure and temperature as the boilers, and is connected at the top to the main steam-pipe.

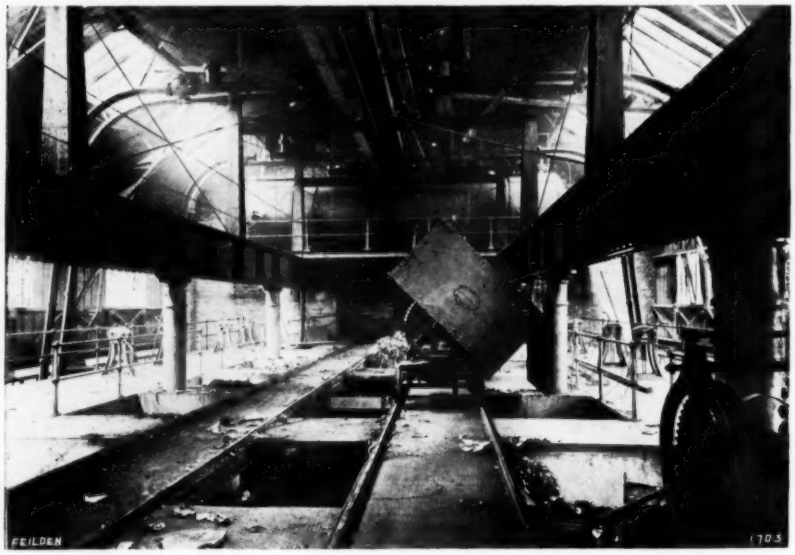

FIG. 19.—SHOREDITCH DESTRUCTOR: TIPPING PLATFORM AND CHARGING APPARATUS.

seven days per week. Each furnace is fitted with both steam and forced-air blast, but experience favours the latter.

A temperature of 2,500 degs. Fahr. has been attained in the furnaces, and both the firebrick linings and fire bars are found to wear well, the only repairs required being due to mechanical damage by stoking tools striking the firebrick arches of the furnaces.

A Green's economiser, containing 240 tubes, is placed in the main flue near the base of the chimney shaft, and in passing

The storage vessel has also a further advantage in the retention of lime deposit from the feed-water; and after a seven months' run a soft scale, easy of removal, was found, principally in the lower parts of the vessel, where it was 12 ins. in thickness. The deposit in the tubes of the economiser was under $\frac{1}{16}$ in. in thickness, and the tubes of the boilers were found practically clean, the scale averaging only $\frac{3}{32}$ in. in thickness.

This method of storing heated water has been found of material assistance to

the successful working of the Shoreditch plant, and has enabled heavy loads to be dealt with under circumstances which would have otherwise been impossible.

In a twenty-four hour test carried out in December, 1898, five boilers and ten cells were in use for about seventeen hours, and for the remainder of the time (seven hours) four boilers and eight cells were working. The total consumption of refuse was 123 tons, consisting of ordinary domestic and trade refuse and shop sweepings; the therefore, dealt with the refuse at the rate of 14·6 tons per cell per 24 hours.

These tests are all the more valuable inasmuch as the chief object therein was to obtain results representative of the every-day working experience of the plant, and not to show the maximum calorific value of the refuse obtainable under special conditions.

In the above test the water evaporated was at the rate of ·96 lb. per lb. of refuse burned.

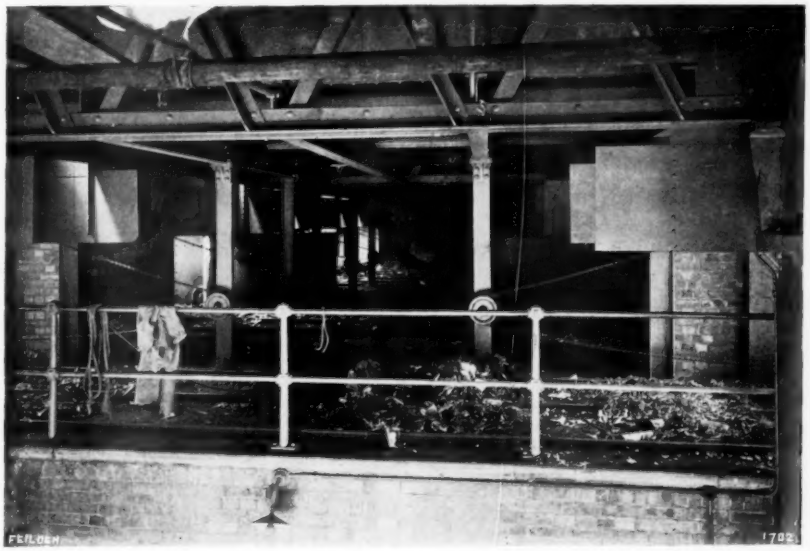

FIG. 22.—SHOREDITCH DESTRUCTOR: THE TIPPING PLATFORM.

amount of electric current produced entirely from this material alone was 4,350 Board of Trade units. When the load reached about 290 kilowatts, or about 430 h.p., the refuse furnaces were then assisted by the coal grates under the boilers. Coal is never mixed with the refuse.

In a second test of 10 hours' duration made in January, 1899, 60·6 tons of refuse generated 4,714 Board of Trade units of electric current. Ten cells were in use and five boilers. The destructor,

The steam generated by the destructor is still further utilised by passing the exhaust from the electric engines to heaters in the wash-houses and public baths adjoining; also, live steam is used for washing purposes, and the feed pump exhaust heats the free library.

Where boilers are arranged for firing with either refuse or coal the provision of suitable dampers should be made, in order that, if required, the refuse furnaces may be entirely shut off from the coal grate, so as to prevent the admission of

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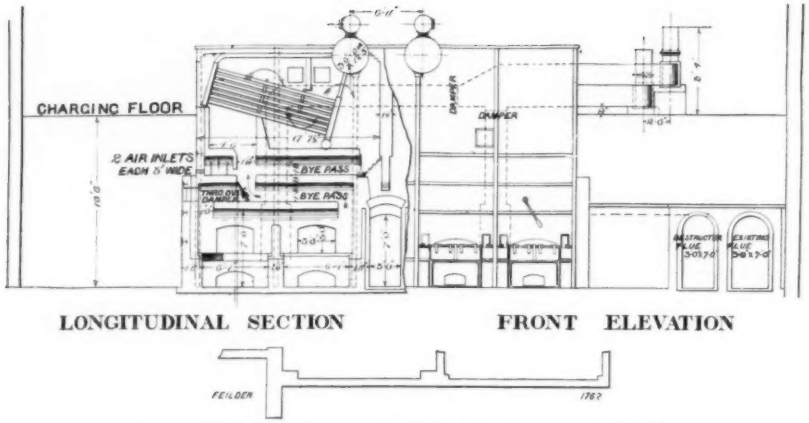

FIG. 21.—"HEENAN" TWIN CELL DESTRUCTOR, FOR THE CITY OF GLOUCESTER.

cold air through the refuse furnace doors, otherwise the full calorific efficiency of the coal will not be secured to a degree obtainable in an independent boiler. This difficulty is experienced at Shoreditch.

The total amount of refuse dealt with at the station during the year ending March, 1899, was 26,201 tons, and the cost per ton of dealing with this mass of material, including labour, supervision, cleaners and yard men, repairs, stores, etc., amounted to 2*s.* 6·9*d.* per ton. In addition to this, the item of interest and redemption on the initial cost of the works amounts to 11·5 pence per ton, including the repayment in 30 years for buildings, plant and land. This figure is large owing to the costly nature of the works, due largely to the conditions of the site.

The resulting clinker from the destructor amounts to about 33 per cent. of the bulk dealt with. A portion is used for the manufacture of artificial paving stone. The economical disposal of this residue in a built-up area like Shoreditch is a somewhat difficult question, owing to the large quantities produced and the cost of cartage.

For the year ending 25th March, 1899, the total amount of electric energy metered to consumers, including current supplied to the destructor, was 1,031,348 Board of Trade units, and of this it is calculated 708,788 units are due to the refuse, and the remaining 322,560 units were produced by coal. The fuel consumed was 26,201 tons of refuse and 1,344 tons of coal.

Assuming the current generated to be worth 3*d.* per unit, this would give an annual revenue of nearly £13,000. If from this we deduct the cost of cremating 26,000 tons of refuse at 2*s.* 6*d.* per ton, that is £3,250, also the cost of the coal used, amounting to £1,308, this leaves a balance of £8.442 per annum for other expenses and profit.

It is found that the average amount of electric energy used in treating the refuse is 4·98 Board of Trade units per ton. Of this 4 units per ton are absorbed in the electric fans, ·5 unit in the electric lifts and tipping trucks, and ·48 unit in lighting. The comparatively large amount of current used in the fans is partially due to the fact that the destructors are worked on the eight-hour shift system, and seven days per week, necessitating some of the fans being always in use, oftentimes running several weeks continuously. There are three Sturtevant fans, each designed to supply 8,000 cubic feet of air per minute. All the fans are not in continuous use except during the periods of heaviest load. They are driven direct

by a shunt-wound electric motor, and are run at a speed of about 650 revolutions per minute. The inlets of the fans are so arranged as to draw the heated air away from the platform of the destructor.

The experience at the Shoreditch station goes to show that the calorific value of London refuse is practically 1 lb. of water evaporated per pound of refuse burned, and that this material is of considerable commercial value for purposes of steam raising; also, that it may be relied upon as a fuel for generating high-pressure steam for electric lighting and motive power purposes.

Figs. 18, 19, and 20 show the front view of the furnaces and boilers, and the tipping platform and charging apparatus.

BAKER'S PATENT REFUSE DESTRUCTOR.

The Destructor system of Messrs. Baker & Sons, of Willesden, contains new features, as will be seen from the accompanying illustrations (Figs. 25—27), which show the latest model of this type. It will be seen that the drying hearth is built over the furnace proper, and forms the bottom of an independent chamber or hopper. The hopper may be of any size, the one illustrated (which is for a plant constructed for the City of Buenos Aires) having a receiving capacity of 10 tons at a single charge.

The moisture and gases arising from the drying refuse are withdrawn from this chamber by the forced-draught fan, and driven with the air supply into the ash-pit and through the fire-grate.

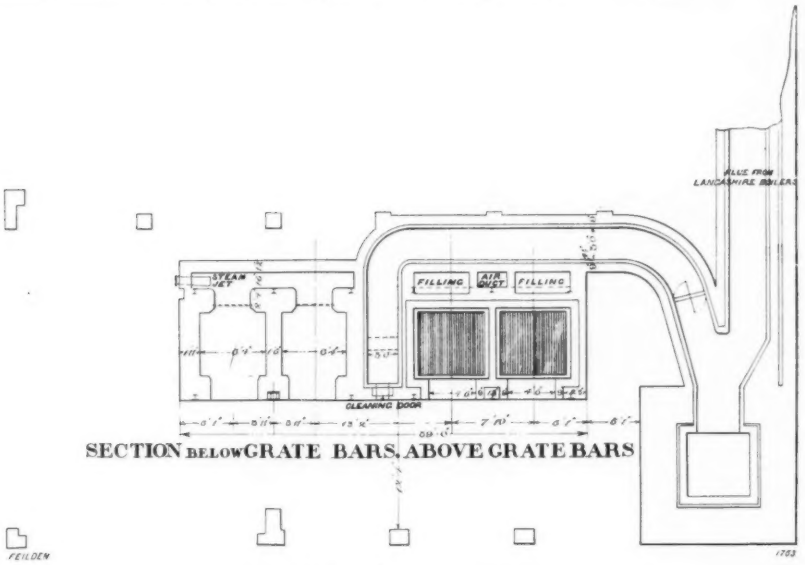

FIG. 22.—"HEENAN" TWIN CELL DESTRUCTOR.

The inclined floor of the drying-chamber or hopper delivers direct to the upper end of the fire-grate. At this end a stoking-door commands the refuse at short range and enables the stoker to perform his work with ease and comparative comfort, the refuse intervening between him and the intense heat of the furnace.

The work of clinkering is done through a door of special construction at the other end of the fire-grate. This clinkering-door is of sectional pattern, with a small opening, through which the greater part of the operation of clinkering may be

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done with convenience to the workman, and without the loss of heat occasioned when the entire furnace-door is open. The large extended dead-plate is designed to allow of the partial cooling and sorting of clinker before discharge. In large plants where a clinker conveyor is used, the dead-plate is made collapsible, and delivers through a shoot to the conveyor below.

The standard size of grate-area adopted by Messrs. Baker & Sons for their destructor cells is 42 sq. ft. It is found that one man can conveniently do all the stoking and clinkering of two cells of that size. At a formal trial recently of the Phœnix Wharf Plant, Lambeth, a combustion of 27 cwt. per cell per hour was attained. The following are the particulars of the performance of one cell :—

Description.	Result.
Duration of test	2 hrs.
Time of test	10.15 a.m. to 12.15 p.m.
Date	8th Feb., 1901.
Weather	Dry and dull.
Thermometer	38° Fahr.
Refuse burnt	2 tons 15 cwt. 2 qrs.
Refuse burnt per hour	1 ton, 7 cwt., 3 qrs.
Clinker, 2 cwt. 3 qrs. 14 lbs. / Ashes, 8 cwt. 0 qrs. 20 lbs.	11 cwt. 0 qrs.
Percentage of above	20%
Nature of Refuse	Light separated market and warehouse refuse, and household refuse from ashpits, containing no cinders or ashes.
Percentage of moisture	21½%
Temperature of cell (approx.)	1,350° Fahr.
Temperature of flue	950° Fahr.
Temperature of drying box	240° Fahr.
Steam pressure in boiler	80 lbs.
Smoke from chimney	Just perceptible at short intervals.
Number of times cell was clinkered	Once.
Dust collected in separator	Inappreciable.

By a check door which is controlled by the stoker, and may, if required, shut off the refuse altogether.

By means of an opening over the stoking-door the stoker may, if necessary, examine and manipulate the refuse, without the necessity of going up to the tipping platform.

Dampers of special sectional fire-clay pattern, easily renewable in case of accident, are fitted to all the flues. A by-pass between the drying hopper and ash-pit allows of the plant being worked with natural draught.

In this destructor the attempt made in some of the types of cells described to combine within the furnace chamber the operations of desiccation and combustion is abandoned. The fire-grate occupies the entire bottom of the furnace, and the

The fires had only been started for a few hours before the experiment began, and it is likely that as the work went on the temperatures in the drying-chamber, furnace, and flues would rise considerably, with a corresponding increase in the output.

The feed of the refuse from the drying hopper to the fire-grate may be adjusted

problem of combustion, in so far as the furnace is concerned, is confined to the refuse upon the fire-grate.

Owing to the moist and often sodden nature of household and towns refuse, desiccation prior to combustion is needed, and Messrs. Baker & Sons, instead of attempting to accomplish this within the furnace chamber, dry the refuse

separately, and utilise the resultant moisture and gases of distillation as fuel by passing them along with the air-supply through the fire-grate.

The makers advocate a large drying chamber, up to a capacity of 10 tons at a charge. By such an arrangement, it is believed, the refuse is more completely rid of its moisture and volatile elements, and may be assumed to arrive on the fire-grate as a more or less normal and innocuous fuel. The gaseous elements are destroyed, and the problem of combustion in the furnace itself is simplified by being restricted to solid fuel not easily gasified. It will be seen that the drying-chamber may be enlarged to the full storage capacity required in a Destructor Station, so that the refuse may be discharged direct from the collecting vans into the cell, attendance on the latter being therefore reduced to the operation of stoking and clinkering.

The forced draught consists of a Steam Jet Air-blast.

A plant of this type has been put down at Lambeth, consisting of two cells of 42 sq. feet grate area each, one Hornsby boiler of 20 h.p., one Sturtevant Induced fan with vertical direct coupled engine, and one centrifugal dust collector set between the fan and chimney.

The cells are sunk below the level of the ground, but the boilers are not. The drying hopper is not specially enlarged. The refuse is screened by the Corporation, the ashes, etc., being sold. The chimney, which is an old one on the site, is too small for its work, being only 24 ins. diameter, of square section, and only 56 ft. in height. The labour includes one stoker, one boy to feed, and one engineer to look after the boiler and engines. The plant works one 8-hr. shift per day, and starts cold each morning. The average consumption of refuse is 12 to 14 tons daily, that is 6 to 7 tons per cell per 8 hrs.

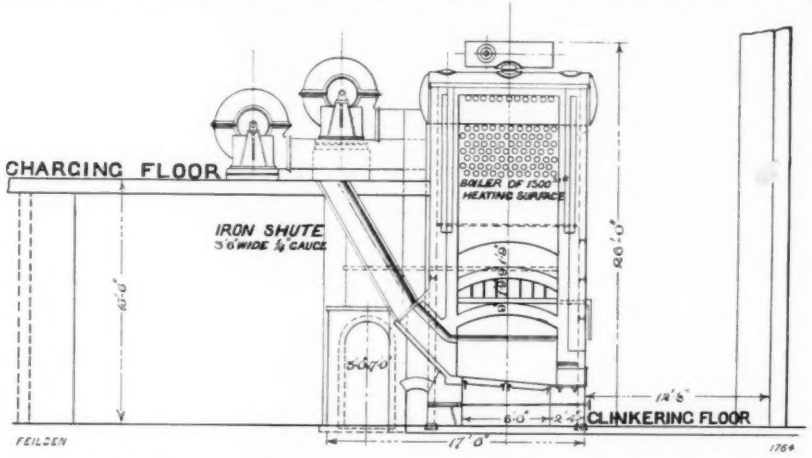

FIG. 23.—"HEENAN" TWIN CELL DESTRUCTOR: CROSS SECTION SHOWING MODE OF FEEDING FURNACE THROUGH IRON SHUTE.

The illustration (Fig. 26) shows a type of cell which is being made for the Buenos Aires Municipality, and which embodies improvements not contained in the Lambeth plant. The Buenos Aires plant is fitted with forced draught instead of induced. The drying hopper, as will be seen, is much enlarged. The inner cheek door and back inspection door are advisable only in cases of such a hopper.

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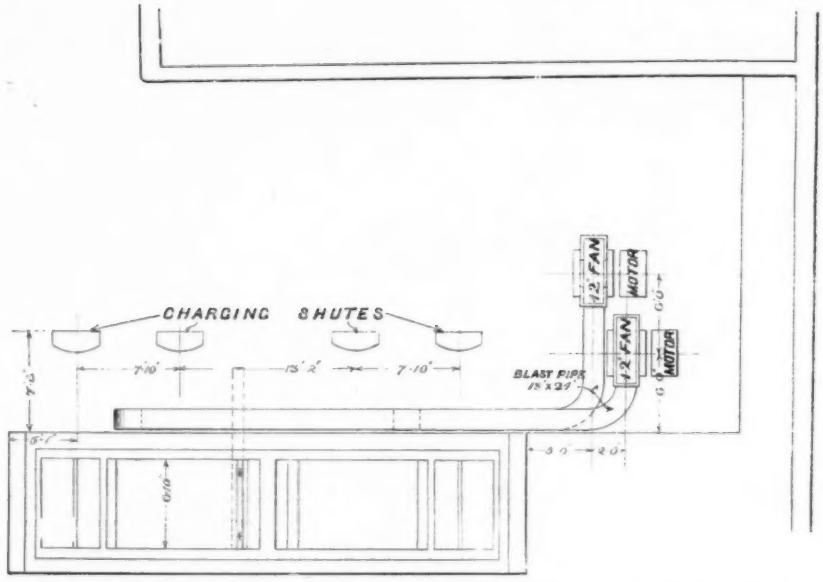


FIG. 24.—"HEENAN" TWIN CELL DESTRUCTOR: PLAN AT CHARGING FLOOR LEVEL, SHOWING CHARGING SHUTES AND FORCED AIR DRAUGHT.

POINTS IN THE DESIGN OF A DESTRUCTOR STATION AND PLANT.

It is only within quite recent years that the proper design and capabilities of the refuse destructor and its accessory plant have begun to be fully understood. The utilisation of refuse as fuel is an essentially practical subject, and one in which every "improvement" must first be submitted to a prolonged practical test before it can be pronounced as good. The best steam-raising results obtained to-day are secured from a knowledge of, and the consequent avoidance of, the failures of the past. Like most mechanical apparatus and inventions, that destructor plant is best which is simple, strong and workable, combined, of course, with efficiency. It would be unwise to lay down any hard-and-fast rule as to any particular type of plant or system in refuse destruction as being absolutely the best and applicable to all cases and localities. There are several good plants which have their respective distinctive features, and which may be desirable in one place but not in all. Due regard must be had to local requirements. The choice of plant and the general design of a station requires to be entrusted to an engineer experienced in such matters, in order to ensure the best results. Speaking generally, however, the following observations should be borne in mind:—

The temperature in the cells must be sufficiently high to reduce the refuse to an entirely innocuous clinker, and all vapours given off should pass through an adjoining red-hot cell, or through a chamber whose heat is maintained by the ordinary working of the furnaces themselves to a temperature of from 1,500 deg. to 2,000 deg. Fahr., so as to prevent the escape of noxious gases.

To maintain a uniformly high temperature, the destructor requires to be so worked, that whilst one set of cells is re-charging, another set is at a full red-heat.

The furnaces and plant require to

be strong, simple, and easily worked without stoppages, and should contain no mechanical complications. It should well withstand variations of temperature, and readily admit of being repaired when required. The plant must admit of being readily understood and worked by stokers of average intelligence, so that its continuous working may be ensured, and that the cost of working may be kept as low as possible.

Clinkering and re-charging requires to be done as speedily as possible to prevent the inrush of cold air, thus reducing the temperature of the main flues and the calorific efficiency of the refuse. Where boilers are provided for stoking with both refuse and coal, a system of dampers should be arranged so that when coal fuel is in use, only the refuse cells may be shut off from the boilers, otherwise the cold air passing through the cells and into the coal furnaces will materially reduce the calorific efficiency of the coal.

The chimney draught must always be assisted by forced draught from fans or steam jet to the extent of from 1·5 to 2 ins. of water-gauge pressure in the ash-pit. In neighbourhoods where the question of nuisance from the chimney shaft is of importance, boilers must not be placed immediately over a furnace in such a way as to present a large cooling surface to the gases such as to reduce their temperature before they have been rendered wholly innocuous.

Where steam power is an important part of the system ample boiler capacity and hot-water storage feed tanks should be provided: also the flue gases may be utilised in heating the air supply to the grates and the feed water to the boilers. For a high fuel efficiency a large proportion of CO_2 should be sought in the cells with as little excess of air or free oxygen as possible.

Considering the somewhat trying nature of the work, a destructor station should be worked in three eight-hour shifts. A bath-room in connection with the works will also be found a boon by the workmen.

In order to derive the full advantage of

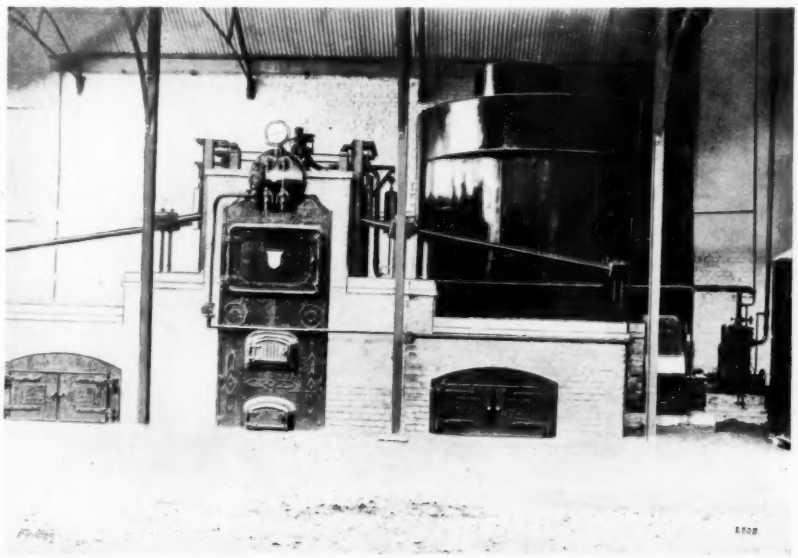


FIG. 25.—BAKER'S PATENT REFUSE DESTRUCTOR.

good points of design, it is necessary that the furnaces and plant be carefully and intelligently worked, and the efforts of the firemen should be towards obtaining a good, hard vitreous clinker, perfect cremation of the whole of the refuse without the escape of unconsumed vapours of any kind; also the inrush of cold air into the cells and flues must be avoided as much as possible, otherwise the calorific results obtained will be low.

COST OF ERECTION OF DESTRUCTOR.

This will depend very largely upon local circumstances, the nature of the site, type of destructor adopted, etc. At Leyton, in 1897, an eight-cell Beaman & Deas destructor, capable of dealing with about 20 tons of house refuse per cell per 24 hours, was erected at a cost of about £7,000. This amount included the cost of 8 cells complete, an iron building with all roof and girder work, tipping platform, etc., inclined roadway, two 100 h.p. Babcock & Wilcox boilers, and two 12 h.p. engines, fans, chimney shaft 150 ft. in height, and incidental accessory items. Four of the cells are usually (occasionally six are necessary) found capable of dealing with the town refuse and sewage sludge cake from a population of over 100,000, and amounting to about 65 tons per day.

At Darwen, in 1899, a two-cell Meldrum destructor of 104½ sq. ft. grate area, capable of dealing with about 56 tons of refuse per 24 hrs., was erected at a cost of £6,730, including cells, two Lancashire boilers, regenerator, brick and stone buildings with corrugated iron sides, and chimney shaft 240 ft. in height.

At Bristol a 16-cell Fryer destructor, erected in 1892, cost £6,820 for cells alone, or about £426 per cell.

COST OF BURNING REFUSE.

The average cost per ton of burning refuse in destructors in 24 towns throughout the country is 1*s.* 1½*d.* per ton; this is exclusive of repayment and interest on the cost of the works.

At Shoreditch the average cost for one year, including supervision, stores, etc.,

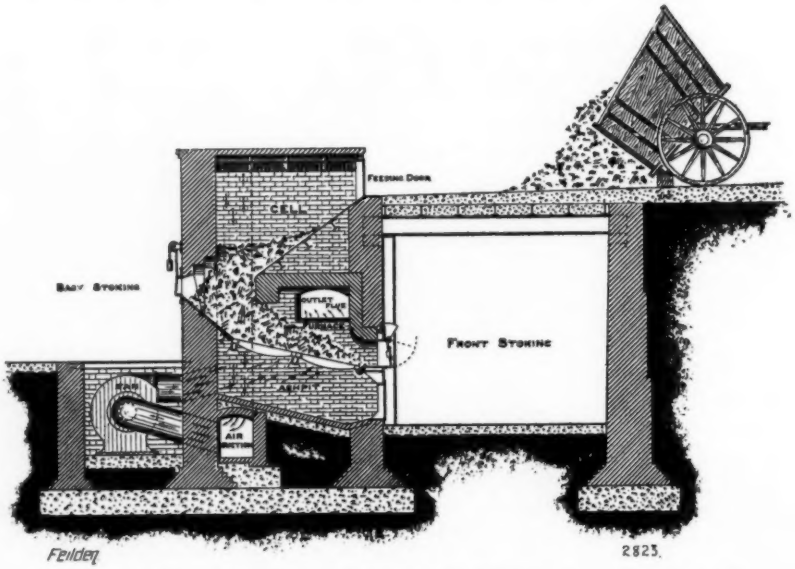


FIG. 26.—ILLUSTRATION OF STORAGE HOPPER TYPE OF BAKER'S DESTRUCTOR CELL SUPPLIED TO THE BUENOS AIRES MUNICIPALITY.

in addition to labour and repairs, but not including interest on cost of works, amounted to about *2s. 6d.* per ton. At Battersea the cost is as much as *2s. 10d.* per ton, whilst at Bradford the refuse is burned for about *6d.* per ton.

A cost of *1s.* per ton for labour, repairs and supervision is a fair average figure. The exact amount, however, will naturally depend upon the price of labour in the locality, upon the nature of the material to be dealt with, the disposal or utilisation of the residue clinker and ash, and other like circumstances.

The amount of refuse burned per cell per hour materially affects the cost of burning. For purposes of comparison the best way of stating the duty of different type furnaces is to state the performance of the furnace in pounds per square foot of grate area per hour, as different furnaces have varying grate areas, and to give the consumption in tons per cell is apt to mislead.

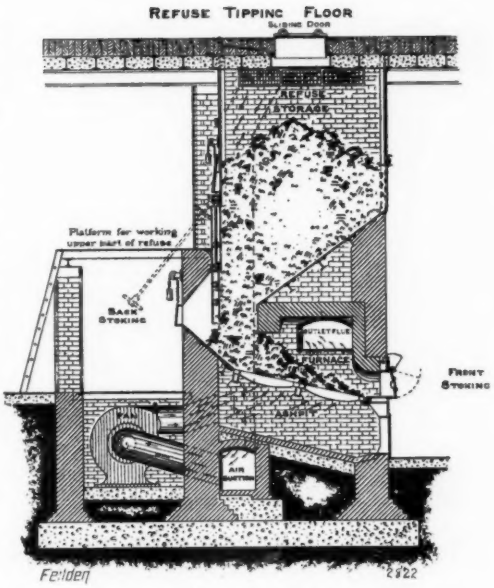


FIG. 27.—TYPE OF BAKER'S DESTRUCTOR CELL SUPPLIED TO THE CLERKENWELL VESTRY.

The ordinary low-temperature destructor, working without forced draught, deals with about 20 lbs. of refuse per sq. ft. of grate area per hour, and this gives, for a grate area of 25 sq ft. each furnace, a duty of between five and six tons per cell per day of 24 hours. This consumption is low, and with forced draught may be greatly increased. The Beaman & Deas furnace at Canterbury has been found to deal with as much as 77·5 lbs. per sq. ft. of grate area per hour, and the same type cell at Llandudno deals with 71·7 lbs. per sq. ft. per hour. The consumption in the Meldrum furnaces at Rochdale is 66 lbs. per sq. ft. per hour.

The amount passed through the furnaces depends largely, however, upon the mode of stoking, upon the degree to which the material is thoroughly cremated, and the frequency of the removal of clinker.

The amount of residue clinker produced is usually between 25 and 33 per cent. of the material dealt with. Its ultimate disposal is a question of considerable importance in built-up districts, where the ordinary outlets for the material are not available, as the cost of cartage or barging to the suburbs of the town is almost prohibitive in many districts, as is the case in Shoreditch, where the total residue amounts to 32·8 per cent.

Where a demand exists, the clinker is useful as hard-core for forming bottoming for macadamised roads. It is also sometimes crushed to small size and mixed with cement for making paving slabs. It may also be used for making a rough concrete where great strength is not required, and, in many districts, a very general use is grinding in a pugmill for mortar-making.

DO DESTRUCTORS CREATE A NUISANCE?

At the early introduction of the practice of cremating refuse in furnaces the subject was imperfectly understood, the furnaces in use were of bad design, and the general result was unsatisfactory. The necessity of dealing with town refuse by fire has

from that time grown more and more apparent, and a good deal of attention has consequently been devoted to its better achievement. The result is, at the present time, very important improvements have been made in the design and working of refuse furnaces, the essential points in dealing with the material have been learnt from the experience of others, and the operation may now be carried out in the midst of thickly populated areas without nuisance or inconvenience to the surrounding inhabitants provided the plant is properly designed and worked.

The introduction of a good forced draught and high temperature furnaces has enabled larger quantities of material to be dealt with and with less risk of allowing unconsumed vapours to escape into the atmosphere. The temperatures attained in the best destructors are as much as from 1,800° F. to over 2,000° F.

In the modern furnace these large quantities of heat energy are not allowed to run to waste, but are intercepted in suitably placed boilers and utilised in generating steam power for Municipal Electric Lighting and other public services. Refuse has thus gradually grown to be looked upon as "fuel" of a certain and fairly definite commercial value, rather than as waste material to be got rid of. In fact, in some districts where it is thus utilised to the full extent, an actual demand has arisen for the material for purposes of steam raising.

As in the case of coal, attention is therefore now directed, in the design and working of the furnaces, to the question of obtaining its full calorific value and preventing waste by the admission of excessive quantities of air into the furnaces, and by other means.

THE ECONOMETER.

The efficiency of the combustion of the refuse is measured by the econometer. The instrument measures continuously and automatically the percentage of carbonic acid escaping in the gases given off in the furnace. The proportion of carbonic acid should be large, and that of free oxygen (an excess of air) small. The percentage of CO_2 is increased by reducing the air supply, and the percentage may thus be forced up until the combustion is shown to be incomplete by the presence of carbon monoxide in the chimney gases. The higher the percentage of CO_2, the more efficient the furnace, provided no CO is formed.

The theoretical amount of carbonic acid for refuse burning is about 20 per cent. Owing to the small percentage of carbon and other combustible material contained in town refuse, a less quantity of air is required for its combustion than is the case with coal.

If the proportion of free oxygen is large, more air passes through the furnace than is necessary for complete combustion, and the heating of this excess is a waste of heat.

In tests made by Lord Kelvin and Professor Barr, M.I.C.E., upon a Horsfall destructor at Oldham, it was estimated that the air consumption averaged 2·1 lbs. per pound of refuse burned, *i.e.*, equal to about 27½ cubic feet at the ordinary atmospheric pressure, the air being delivered into the ashpit under the furnace at a pressure of from ·88 to 1·38 ins. of water column.

In testing the percentage of CO_2, the econometer should be as near the furnace as possible, to avoid air leakage through the brickwork of the flues.

FUEL VALUE OF TOWN REFUSE.

From data already given it will be seen that the calorific value of house refuse varies from 1 to 2 lbs. of water evaporated per pound of material burned. The exact evaporative efficiency will naturally vary according to the nature of the refuse in each locality, but assuming the value of coal at 10 lbs. of water evaporated per pound of fuel, this gives a calorific value for refuse of from one-tenth to one-fifth that of coal. Putting the price of coal at 20*s.* per ton (which is low compared with recent experience in London) we have a commercial value for town refuse of from 2*s.* to 4*s.* per ton as a low-class fuel for steam-raising purposes.

If all the refuse of London, amounting to about 1·25 million tons annually, were

burned in suitably constructed furnaces, and the heat thus generated properly applied to the production of steam, even when calculated upon the low evaporation of 1 lb. of water per lb. of refuse, the total power to be derived per annum from this source would amount to something like 138 million brake-horse-power hours.

Now if this be calculated out upon the basis of using 4 lbs. of coal to the brake-horse-power per hour, with coal at 20*s.* per ton, each brake-horse-power hour costs ·43 of a penny, or the fuel value of the London refuse is, on this basis, equal to about £247,000 annually.

Several destructor plants in provincial towns are now yielding large quantities of steam power for various municipal services. Amongst these may be mentioned—

Town.	Total indicated H.P. developed per hour, calculated upon a basis of 20 lbs. of steam per indicated horse-power hour.	Steam Pressure: lbs. per sq. in.	Use to which Steam is Applied.
Hereford	236	71	Pumping sewage.
Darwen	275*	183	Public electric lighting and motive power.
Canterbury	236	132	,, ,, ,, ,,
Rochdale	350	113	Working machinery at sanitary manure works, etc.
Oldham	200	128	Public electric lighting, corporation workshops, etc.

In combined destructor and electric or other power-using undertakings it is found almost impossible to utilise the *entire* thermal energy given out by the destructor plant without some means of storage of energy, inasmuch as the destructor usually works continuously at a fairly uniform rate, whilst the demand upon the electric generation plant is very irregular. In electric lighting the period during which the demand for current exceeds the mean demand does not exceed about six hours out of the twenty-four, whilst for a portion of the time the demand may not exceed $\frac{1}{20}$th of the maximum demand.

The difficulty thus arising will be very materially reduced in districts where a day load exists, such as in the running of motors, lifts, tramways, etc., whereby the load upon the plant and upon the destructor boilers will be fairly equalised throughout the 24 hours.

The irregularity in demand is also further met by the introduction of feed thermal storage vessels, in which hot feed-water is stored during the periods of light load, probably 18 out of the 24. At the time of full load the boilers are then fed direct from these storage vessels which work at the boiler pressure and temperature.

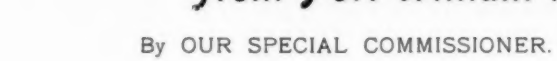
From experience gained at steam-raising destructor plants, such, for example, as in the towns named above, it may be accepted therefore that, in suitably designed stations, town refuse may be relied upon to generate high-pressure steam for the generation of electric energy or other uses, that refuse has a fairly definite calorific and commercial value for this purpose, and that its treatment by fire under the conditions dealt with is not only the most sanitary, but also the most economical and perfect method of disposal of the refuse of towns.

* This has now been considerably increased since the adoption of tramways and the fuller use of the calorific capacity of the destructor.

XUM

West Highland Railway Extension from Fort William to Mallaig.

By OUR SPECIAL COMMISSIONER.



IT was not until 1894 that the Western Highlands were rendered accessible by rail, when in that year the North British Railway, under the title of the West Highland Railway, completed the extension of their system from Glasgow to Fort William and Banavie on the Caledonian Canal.

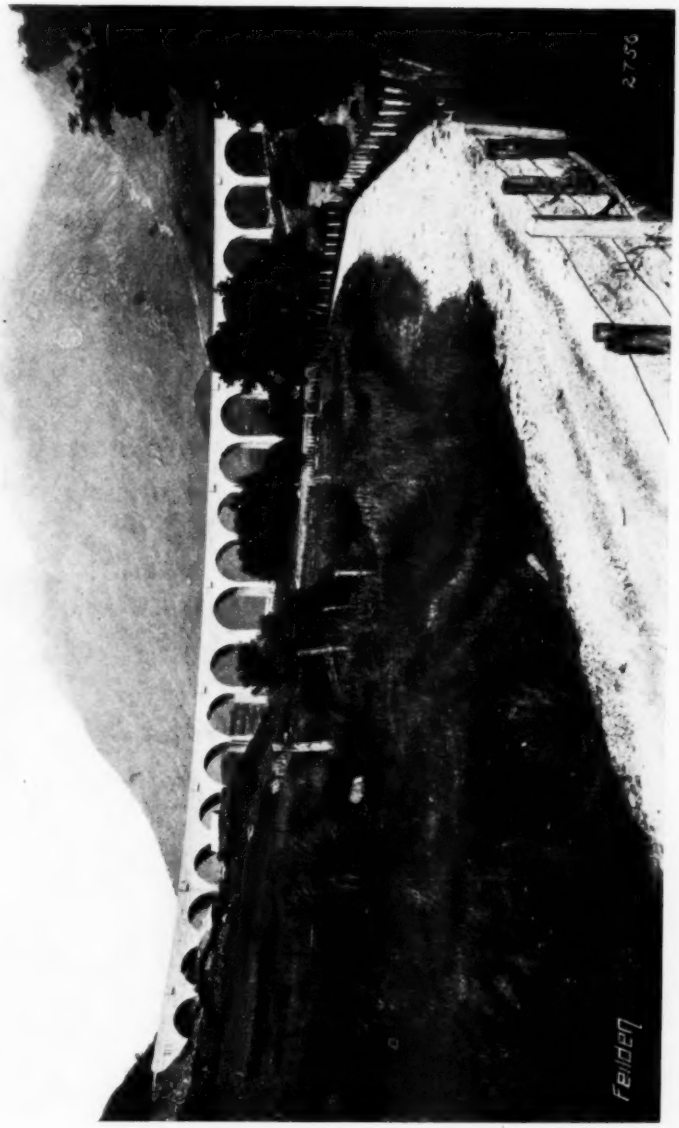
Even then the Hebridean group of islands were not, at any rate as far as merchandise traffic was concerned, placed in possession of facilities for more favourable and rapid communication with the south than had up to that period existed.

The large fishing and agricultural interests existing in these islands, however, seemed likely to provide, to a discerning Board of Directors, an important source of revenue, although perhaps hardly sufficient to justify an expenditure of some £260,000, the estimated cost of an extension from Fort William to Mallaig, a point on the mainland which would, under communication

MAP OF THE WEST HIGHLAND RAILWAY EXTENSION FROM FORT WILLIAM TO MALLAIG.

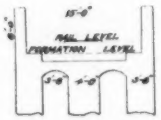
Supplement to

XUM

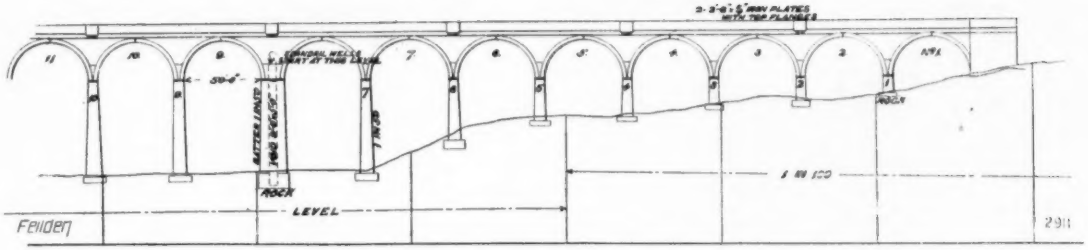


GLENFINNAN VIADUCT, AT 14 MILES.

PLAN.

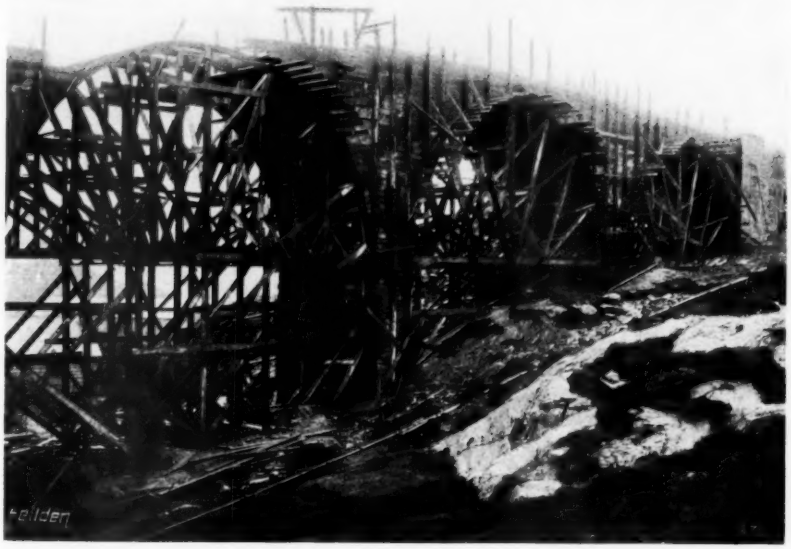


CROSS SECTION OF JACK ARCHING AND SPANDRIL WALLS.



SECTIONAL ELEVATION.

DETAILS OF GLENFINNAN VIADUCT.



GLENFINNAN VIADUCT: CENTREING FOR ARCHES.

by boat with the island of Skye, be a matter of only two or three hours, and bring Stornoway within twenty-four hours of London.

The Government, however, recognising the value of such a scheme, were ready to guarantee a subsidy of 3 per cent. for thirty years on the above-mentioned capital sum, and a further £30,000 towards the cost of constructing a pier and breakwater at the Mallaig terminus.

A commission having already reported upon the practicability of the route, the contract for construction was let to Messrs. Robert McAlpine & Sons, of Glasgow, the engineers being Messrs. Simpson & Wilson of the same city, a firm who have had long associations with the North British Railway Co., and to whom and their resident engineer, Mr. W. Currie, the writer is indebted for photographs, much of the information, and for a pleasurable journey over the route.

The line, as may be seen from the accompanying map, commences at a point half-way between Fort William and Banavie, at which spot the first sod was turned in January, 1897. The nature of the country traversed was such as to cause the work to be somewhat protracted, and it was not until April of this year that the line was opened for traffic.

In spite of the difficulties and the mountainous country, there would, but for one fact, probably have been little in the works and structures themselves to have saved this length from engineering commonplace, that one fact being that all bridges and viaducts—some, indeed, of considerable dimensions—are constructed throughout of concrete, a method in railway practice sufficiently rare as to have attracted the attention of many of our leading engineers.

Those who have examined the works have been greatly impressed with their durability and weather-resisting qualities. The writer is assured also of the economy of the method, as far as rocky country is concerned and where the cost of quarry-

XUM

ing and masonry would be held to be cheaper than brickwork.

The composition of and method of preparing the concrete is as follows :—

All the concrete used was composed of four parts of broken stones or gravel to one part of the best Portland cement, and such quantity of sand as was found necessary. The greater part of the stones were taken out of the rock cuttings and were put through a "stone-crusher." In the abutments, piers, and walls, etc., displacers were put in, with about four inches of concrete surrounding. The concrete in the arches of all the bridges and viaducts was four to one, but no displacers were allowed. No tests were made of the concrete, but the cement used was constantly tested: the cement was specified to stand 400 lbs. per square inch after seven days' immersion in water. No difficulty was experienced in getting this, and it was often found to be over 600 lbs. per square inch, and in one or two cases as high as 750 lbs. per square inch.

The photographic reproductions given herewith of the more important structures show that in appearance they leave nothing to be desired; in fact, at a very short distance off, it would be difficult to discern any difference from cut stone.

The method of construction may be gathered from the illustration on page 241, from which it will be seen that, after the parapets and piers had been moulded up to the spring-ing of the arch, ordinary centerings —of much lighter construction, however, than is usual in general practice—were put in, and the moulding-up continued.

The arches were mostly turned in layers, so that each layer when set served to strengthen the centres for the succeeding layer, the surface of each layer being left rough so as to ensure both layers binding. The spandrel fillings consist of broken rock.

BRIDGE OVER PUBLIC ROAD, NEAR POLNISH, AT 25 MILES 4 CHAINS: TYPE OF UNDERLINE BRIDGE.

Supplement to

XUM

ARNABOL VIADUCT, AT 26 MILES 16 CHAINS.

In the case of the viaduct over the Borrodale Burn, where the span is 127 ft. 6 ins., and the rise of arch 22 ft., the arch and approaches only are in concrete, while the parapets are of *stone*, the latter course being adopted owing chiefly to the length of span—which, by the way, is the largest constructed of concrete in Great Britain—and as offering a more stable resistance to the thrust of the arch.

A double-span skew bridge at 10 miles from Banavie, carrying the railway across the Dubbhighe River, is the only bridge on the length in which an iron superstructure occurs.

By far the most important of the viaducts, and indeed of the whole of the works, is the Glenfinnan Viaduct, carrying the track across a ravine notorious as being the spot where Prince Charlie unfurled his standard in 1745, and which is now marked by a monument erected in commemoration of the event by Glenaladale.

This structure, of which the photograph serves to give a very good idea, is a handsome one, and in no way detracts from the natural beauty of surrounding scenery. It is 416 yds. in length, consisting of 21 spans each of 50 ft., rising to a maximum height of 110 ft. The arches, which are semicircular in shape, are 2 ft. 6 ins. at the crown, with a rise of 25 ft. Two of the central piers are 21 ft. in length by 15 ft.; are 15 ft. at the springing level and battered 1 in 50, the remainder being 20 ft. by 6 ft.; 6 ft. at the springing level and battered 1 in 50. The foundation of the east abutment and six of the piers are in rock, and the remainder in good gravel and mountain clay. The maximum depth from the surface to foundation level is 15 ft. No wing walls were necessary. The structure is on a 12-chain curve, and in order to keep the span of the arches to 50 ft. on both sides of the centre line, the pier faces were built parallel to each other, thus increasing their width on the outer side

and decreasing on the inner; the width on centre line is 15 ft. and 6 ft.

Three spandrel walls have been provided, those on the exterior 3 ft. 6 ins. wide, and the central one 4 ft. The spandrel filling consisted of broken rock.

It will be seen from the drawing that two iron plates have been put in face to face at the crown of each arch. Their purpose is to prevent any cracking taking place in the arch should there be any unequal settlement due to the piers being founded on different materials.

Other noteworthy viaducts are those carrying the track across the Arnabol Burn, the valley at the head of Loch-nan-uamh, the Borrodale Burn, and Loch Morar, the leading features and dimensions of which are as follows:—

WEST HIGHLAND RAILWAY EXTENSION TO MALLAIG.

DETAILS OF PRINCIPAL VIADUCTS.

	Arnabol.	Loch-nan-Uamh.	Borrodale.	Morar.
VIADUCT:				
Gradient	Level	Level & 1 in 50	Level & 1 in 75	Level & 1 in 60
Curve	10 chains	Straight	15 chains	Straight
Length	350 ft.	500 ft.	200 ft.	250 ft.
Number and length of spans	6 of 50 ft.	8 of 50 ft.	2 of 20 ft. 1 of 127 ft. 6 in.	1 of 90 ft.
Maximum height from ground to formation level	53 ft.	40 ft.	86 ft.	...
PARAPETS:				
Width between... ...	15 ft.	15 ft.	15 ft.	15 ft.
Length	350 ft.	500 ft.	200 ft.	250 ft.
ARCHES:				
Rise	13 ft. 5 ins.	13 ft. 5 ins.	22 ft. 6 in. (largest)	24 ft. in the 90-ft. span
Thickness at crown ...	2 ft. 6 ins.	2 ft. 6 ins.	4 ft.	3 ft.
Thickness at haunches: Haunches and spandrels are carried to the level of the under-side of the arch.				
PIERS:				
Batter	1 in 50	1 in 50	...	Vertical
Thickness at springing level	6 ft.	6 ft.	...	8 ft.
ABUTMENTS:				
Length on face... ...	21 ft.	21 ft.	...	18 ft.
Thickness	7 ft. 6 ins.	6 ft.	...	3 ft. 6 ins.

Passing from the viaducts to a consideration of the other features of the length, it may be stated at the outset that the country negotiated was by no means easy, most of it being in gneiss, quartz, and quartzose schists, with granite here and there. The only feature approximating to anything like a compensation for the difficulties was that most of the tunnels on the length, of which there are 11, the longest being 350 yds., required no brick or masonry lining.

The table at foot of opposite page contains the more important details.

The tunnels are all of the same section, and were all driven through the various rocks mentioned above. None of them were in soft material. The tunnels were driven by means of compressed air rock

drills, the same as used in the rock cuttings; the explosive used was gelignite.

Most of these, together with the numerous rock cuttings which were necessitated, occur after Kinlocheil is passed, a point 9½ miles from Corpach. This preliminary length is comparatively level. The nature of the ground and the numerous small streams necessitated the construction in this particular section of no less than 60 culverts. On that portion of the preliminary section which skirts Loch Eil, seventeen retaining walls were also constructed.

The sea walls average 9 ft. high, and are 2 ft. thick at the top and 4 ft. at the bottom, and are all built of 4 to 1 concrete with displacers.

TUNNEL AT LOCH-NA-NUACH, AT 27 MILES.

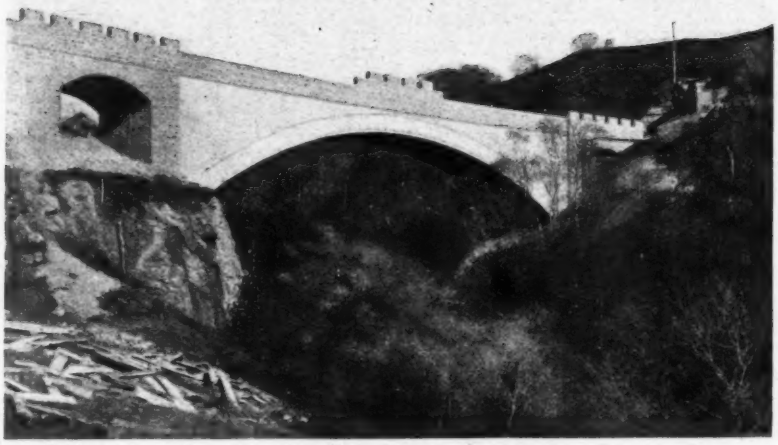
Beds of moss and peat were encountered at numerous places along the line of route, extending in some instances to a depth of 7 ft. In order to secure a good foundation, the moss was excavated and broken rock filled in to give a good foundation.

At 30 miles 50 chains, a bed of moss was met with that reached a depth of 40 ft. As, however, it occurred in a bank of from 15 ft. to 20 ft. high, no excavation was done; but a layer of trees and brushwood was laid across the bank, extending 10 ft. on either side of it.

On top of this was another layer of trees, laid transversely, and on top of this a layer of hand-packed stones, which

TUNNELS.

Miles.	Chains.	Length.	Remarks.
		l.-yds.	
12	75	30	Lined throughout with concrete.
17	53	123	No lining.
17	65	130	Lining at east face only.
24	6	157	No lining.
24	60	23	No lining.
24	66	52	No lining.
27	0	62	Lined throughout.
27	12	103	Partly lined.
27	70	95	No lining.
28	9	109	Partly lined.
29	20	350	Lined throughout.

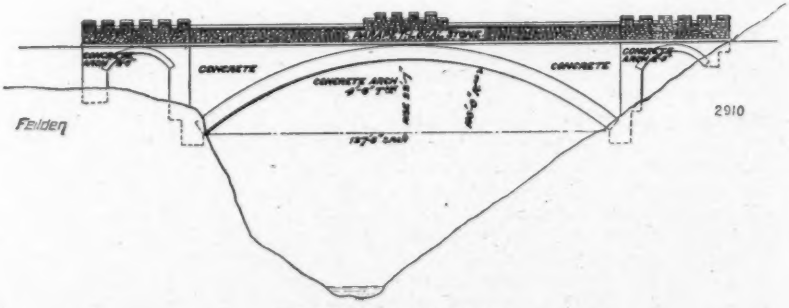


BORRODALE VIADUCT, AT 29 MILES 33 CHAINS: THE LONGEST CONCRETE SPAN IN GREAT BRITAIN.

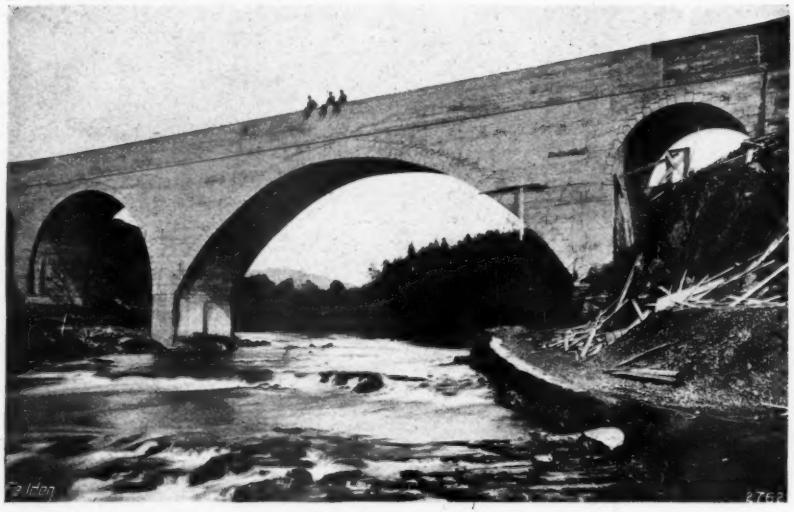
latter secured the even weighting of the trees. The bank was then tipped from wagons in the usual manner.

Water power was used at one point for working the rock drills. Steel pipes, of 21 ins. diameter, conveyed water from a point where the rock had been dammed up to a turbine, which developed 100 h.p. at 900 revolutions, about 150 yds. away. Compressed air was supplied to the drills in the vicinity by a cast-iron pipe laid along the line, tees being fitted at intervals to which was attached a flexible pipe for connecting up the drill. Portable compressors were used for working in the smaller cuttings.

The stations on the new length are seven in number, and are of the usual country



BORRODALE VIADUCT: ELEVATION.



MORAR VIADUCT, AT 36 MILES 18 CHAINS.

type, that at the Mallaig terminus being of the island-platform type. This station adjoins the stone pier which has been erected by the railway company to accommodate the steamers to Portree, Stornoway, &c.

The total length of the line is 39¾ miles, and cost £540,000 to construct, irrespective of the compensation paid to landowners in the district. Materials were brought to the spot chiefly by boat, a temporary line being laid down on the inland lengths.

C. L. Allen

Electrical Machinery at the Glasgow International Exhibition.

By SYDNEY F. WALKER, A.M.Inst.C.E., M.I.Mech.E., M.I.E.E.

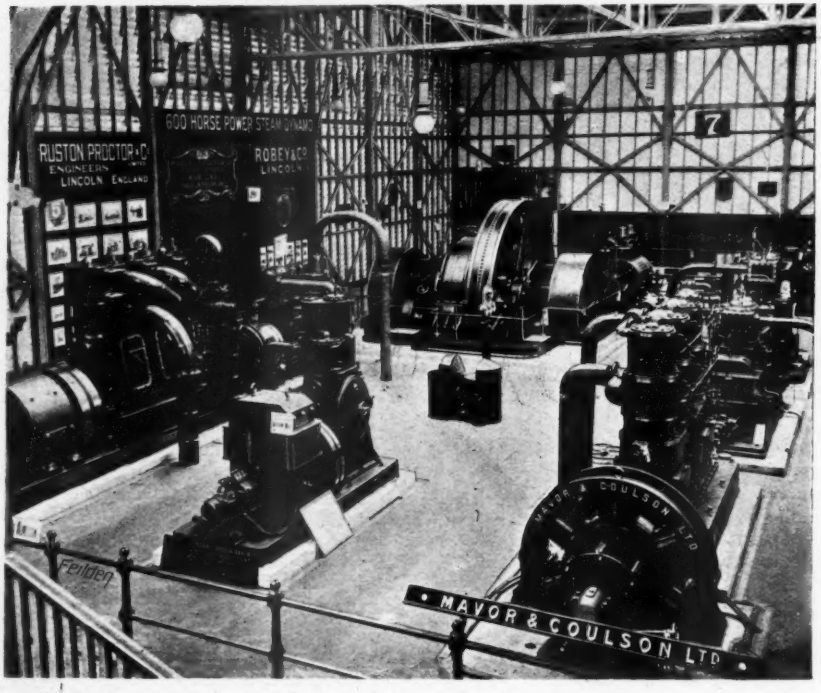
I.

From the standpoint of the electrical engineer, the Glasgow Exhibition appears to be just what an exhibition should be; it represents, as accurately as it is possible to represent such things, the actual position of the electrical industry at the present time. But, in this accurate representation, there occur necessarily startling contrasts, some, in fact, that appear to be almost paradoxical, and yet they represent very faithfully the actual condition.

Electricity appears to dominate everything, yet the semi-classical figure which surmounts the dome of the Industrial Hall, of which there are three replicas over the piazza, is stated by the architect not to be intended to represent electricity, but "Light." And here we are met with the first contrast, and it strikes the note which is found all through the building and the grounds. The figure is that of a female with wings, her hair streaming in the wind, and carrying a torch, and, seeing this figure surmounting the very handsome pile of buildings of which the Exhibition consists, one feels that the reproach which has been so often levelled at modern architects, particularly of late years, that they are unable to design buildings of the grandeur of the old cathedrals, has now to pass away; the architect who designed the Exhibition buildings could have held his own with any of the mediæval architects, and possibly have surpassed them, and then one is brought right down to Mother Earth, one is made to realise that the Exhibition is held in the heart of Puritan Scotland, in its severest form, when one notices that the figure is draped.*

* The architect has kindly informed the writer, in response to his enquiry, that the figure is intended to represent "Light," and that the drapery is intended to give weight to the figure, which is supposed to be alighting on the dome.

But contrast runs all through the Exhibition. Electricity seems to be everywhere, to be seen from everywhere, as the figure is, and yet when it appears to be most dominant, it is really fighting one of the battles which are the almost necessary outcome of its advance into the enemy's country. Just as the invasion of Greek and Oriental ideas of art are resented in the home of Puritanism, and the artist is obliged to compromise by draping his figure, so the invasion of electricity, with its many startling features, is resented by the older servants of the community, and a determined effort is made to bring the young giant to his bearings. And so too, as all thinking men have only respect for the Puritan movement, and for those who carried it through, no matter how much they may differ from its ideas now, in the light of modern freedom, and modern historical research, so also no electrical engineer who thinks of the matter in the proper light can have anything but respect for the old agents, gas, oil, compressed air, steam, shafting, etc., which he is hoping that the agent he represents will displace, but which have done good service in their time, and are to-day able to make a very good fight indeed. And this leads one to the most striking feature of the Exhibition. Electricity has made enormous strides, even since the last Exhibition was held in Glasgow. Where firms were pleased, in those days, very pleased and somewhat anxious, if they secured orders for dynamos to convert 100 h.p. into electrical energy, and where the more common style of order was for machines of 20 h.p., to-day machines of 1,500 h.p. are exhibited running, and they by no means represent the limit, firms who are doing the heavy work being busy with plans for dynamos



POWER END OF MACHINERY HALL, GLASGOW EXHIBITION.

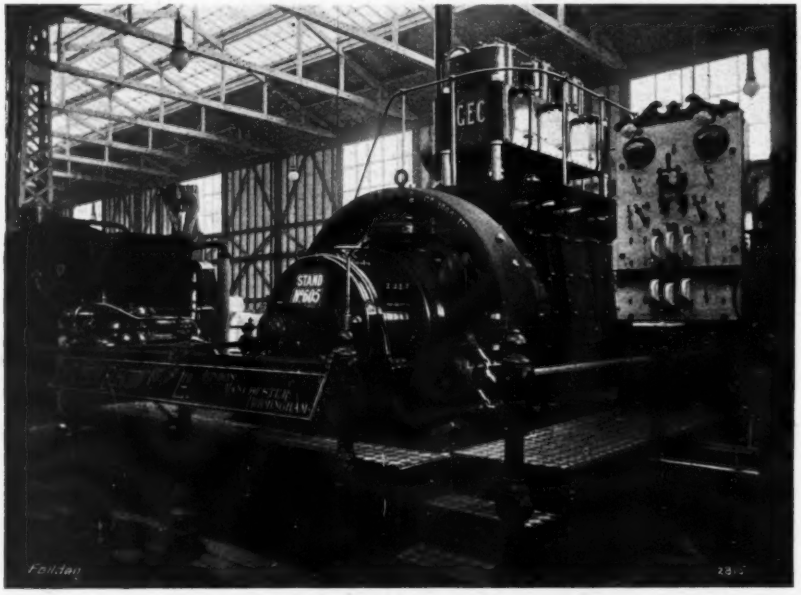
of various patterns up to 7,000 h.p. And plant of 100 or 200 h.p.s eems small compared to what can be done. Where, also, in 1888, 500 volts was thought dangerous, and the proposed transmission by Mr. Ferranti at 10,000 volts almost wanton, to-day we have 10,000 volts handled, within the Exhibition, as easily as a child handles a toy. Yet with all this, notwithstanding the position which electricity has achieved, it is not to be allowed to rest on its laurels. The position that has been won with so much labour and brain power, though it has been apparently so quickly accomplished, is challenged by the older agents, gas, oil, compressed air, etc., and the battle is being fought out, the early stages of it, in the grounds of the Exhibition. As in the old feudal days, the young knight Electricity has to meet all comers, the Exhibition authorities have prepared the lists, and there is a fair fight, such as Britons love, a fair field and no favour, and let the best agent win.

The Exhibition also illustrates somewhat forcibly a process that has been going on in our midst for centuries—viz. the gradual absorption of the foreigner and his gradual conversion into a Britisher, and, further, his gradual conversion to British ideas and British methods as the process of absorption goes on. Our island, as we all know, has always been open to all comers. All have been welcome, without question as to creed, race, or colour, and our island has gained much in past times from the men and women who came to our hospitable shores. In past times they came because they could not live in their own country, owing to religious and political troubles. To-day, though political troubles are rare and religious troubles by

reason of which a man leaves his fatherland still rarer, they still come to our shores; and it is now because they find that which is so aptly illustrated in the Glasgow Exhibition—a fair field and no favour.

In the Exhibition there are three generations of German firms—the firm with a distinctly German name but with the addition of British, whose servants are all German, the majority hardly understanding English; the firm whose German name has disappeared under an innocent impersonal English name, whose leading officials are still German but who employ British labour to handle the goods made in Germany; and the firm, originally German, who now boast that all their goods are made in England, whose chiefs have Anglicised their own names, and on whose board of directors you may hear the homely speech of the South of England. When we call out so much against the invasion of the foreigner in our commercial circles, it is perhaps as well to remember what we owe to similar invasions in times past.

Electrically speaking, the scope of the Exhibition is a very wide one, but again with some notable omissions. Thus generating plant is furnished in the power-station sufficient to perform all the work required in power and lighting several times over, yet the alternate current is totally unrepresented there, and is, in fact, unrepresented in the Exhibition at all, except by one 500-kilowatt three-phase dynamo, by a firm that has only recently entered the market, the Lancashire Dynamo Co., and by apparatus shown by the British Schuckert and Electric Companies, in which alternate currents are furnished by motor generators taking current from the town-supply service; and by the Westinghouse Co. in their pavilion, in a similar manner, the current for the continuous-current side of the motor generator in this case being furnished by a dynamo driven by a Westinghouse gas engine. Possibly this is due to the fact that Glasgow's electric-light supply service is continuous current, at 500 volts,

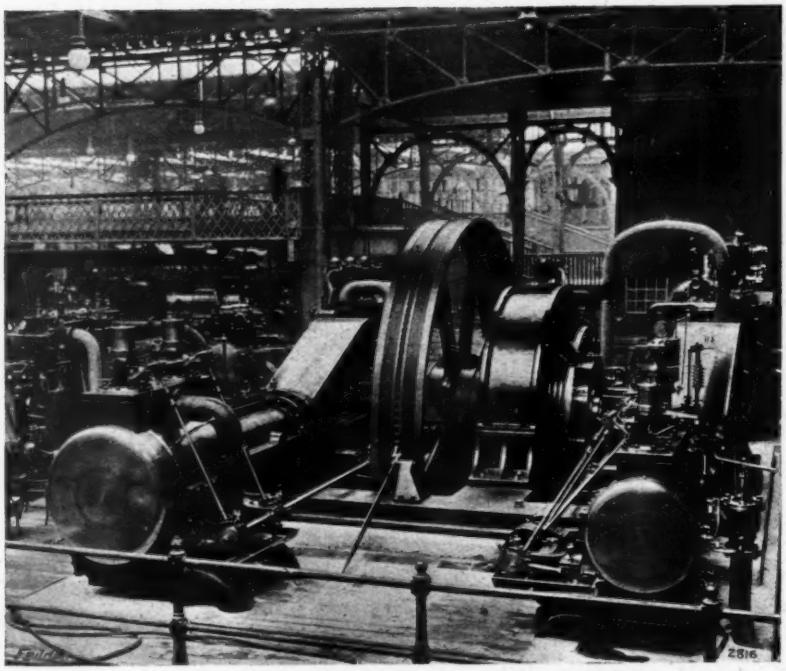


THE GENERAL ELECTRIC COMPANY'S STAND.

three-wire system, and the generating plant is arranged to work in with it.

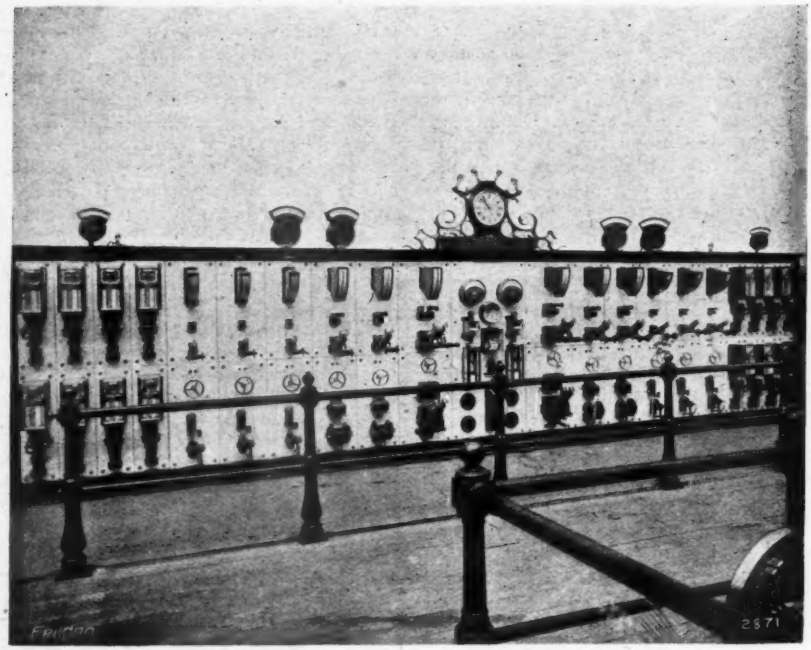
Every form of electric lamp is also exhibited, from the Brockie-Pell arc lamp, which is used to illuminate the main buildings, to the Nernst incandescent lamp. Also every rival of electricity for lighting purposes is fully represented, from the Welsbach mantle, worked with gas at from five to six times the pressure of ordinary gas, to acetylene and the latest form of petroleum lamp, the Notkin; and yet there is an important omission in the ranks of electric-light apparatus. The large electric incandescent lamp, the filament lamp, furnishing from 100 c.p. to 800 c.p., is practically unrepresented. It is to be seen only on one stall, that of a firm whose business is allied to electricity, and at one of the side entrances to the Exhibition; and yet, again, this fully represents the existing state of things. In the early nineties the large incandescent lamp, as represented then by the Sunbeam lamp, taking only 2 watts per candle, bid fair to completely oust the arc. It was shown to be cheaper, whether in confined spaces or in open spaces, and it was more convenient. In South Wales the arc practically disappeared in its favour. Then came the law, the Patent law; its triumphant career was arrested, and it has never looked up since. Gas engineers appear to have taken a leaf out of the electrical engineer's book. They have succeeded in adapting high pressure to their distributing plant, and, with the assistance of a special form of Welsbach mantle, they produce as good a result in lighting the grounds as is produced by the arc light, either in or out of the building, which is saying a very great deal, as the lighting is good all over the place.

The position of power distribution is also well illustrated in the Exhibition. In the Machinery Hall there are three sources of power. Steam pipes run down the hall under the floor, and their presence is known, as usual, by the heat and by the occasional escape of steam. On each side of the hall are lines of shafting, to which the different machines exhibited are belted —lathes, looms, etc. One set of shafting is driven by a 100-h.p. steam engine, which appears to betray a sense of its own importance; it appears to run day by day without any fuss, and as if it was perfectly unconscious of and indifferent to the presence of its pushing young rival across the road. The other line of shafting is driven by a Bruce-Peebles 150-b.h.p continuous current electric motor, and the electric motor appears to be taking matters quite as easily as its rival, while it occupies a very much smaller space. In addition to these there are power circuits round the Machinery Hall, supplied from the generating station, to which any exhibitor requiring current for power purposes can be connected; and there are supplies from certain stalls, that of the General Electric Co. and Messrs. Mavor & Coulson. The advance which has been made, and the resistance to that advance, the present transition state, are well illustrated here. But outside the Machinery Hall there are all sorts of machines working, as well as some in the Machinery Hall, in which the very important advantage that electricity possesses over its rivals, in its very much greater flexibility, are very well illustrated. One comes, in one's walks through the Exhibition, both within the buildings and without, to some machine that appears to be going by itself. Sometimes there is no one near it, sometimes there is a young lady, who now and then turns a handle and the machine moves or stops. You see no straps about, or possibly by careful examination you discover one hidden away somewhere out of sight, and after some trouble you find that a small electric motor is doing the work, the said motor being in some out-of-the-way corner where there is no possibility of making other use of the space, and the current is led to it by cable underground. And you find this applies to such varying machines as those for the manufacture of sweetmeats—of which there are a large number taking power from motors under the floor, the current being supplied by an engine running at the General Electric Company's stall—to looms, sewing machines, cold-air apparatus, the cleaners for Green's economisers, right up to the huge Hoe machine that is printing the evening edition of the *Glasgow Herald*. And the wonderful flexibility of



GENERATING SET BY MESSRS. ROBEY AND CO. AND MESSRS. MAVOR AND COULSON.

the electric current is illustrated in another manner by the exhibits of the British Schuckert Co. and that of the Electric Co., but more particularly by the Schuckert Co. Both of these firms, in common with all the others taking current, either in the buildings or in the pavilions in the grounds, are supplied with continuous current at 500 volts or at 250 volts, as they prefer. Both of these firms take this current and use it at its normal pressure for some of their work, such as, in the case of the Schuckert Co., for driving electric locomotives on a track in the grounds adjoining their pavilion, for driving a 640-h.p. motor that is working a pump, for driving machine tools with motors attached, and, in addition, they drive a motor generator of 160 h.p. which converts the current to three-phase at 500 volts, which is then taken through a transformer and raised to 10,000 volts, at which pressure it is used to illustrate a very pretty high-tension switch, the current being broken with 100 h.p., passing into a tank of water in a manner that a navvy almost could accomplish with a little practice. In addition to this, at their stalls in the Machinery Hall, both of these companies illustrate the principle of high-tension electric transmission by actually transmitting power across their stalls at 10,000 volts. The Schuckert Co. also furnish another illustration of this flexibility; they show a search-light on the top of a tower in the grounds as soon as it is dark enough for the purpose. The search-light works with a pressure of 110 volts 150 ampères, and this is produced, again, from the 500-volt service by a motor generator, the motor taking the current at the 500 volts and the generator delivering it at 110 volts. The point the writer wishes to make is the fact that at the present time the electrical



MAIN SWITCHBOARD IN THE MACHINERY HALL.

engineer is in this position: If you will give him a current—in any form you like, at any pressure—and you will also give him the apparatus he asks for, he can deliver you a current in any form you want, at any pressure, and wherever you want it, at any distance within very wide limits. The Schuckert Co. also show motor generators taking current on the motor side at 110 volts, and delivering it on the generator side at 4 volts for electro-plating and similar work. With all the advances that gas and compressed air have made—and the advances have been very great since the last series of exhibitions were held—there is no sign that they can hope to approach electricity, as a distributing agent, in this matter of flexibility.

There are a large number of dynamos for heavy outputs shown by different makers, from 300 kilo-watts upwards, and they are very instructive, as showing the different lines upon which the English and American and Continental firms work. There is a distinct tendency on the part of English firms to adhere to time-honoured English methods of construction, in which mass is prominent, while on the part of the American and Continental firms the tendency is to lighten the machines in every possible manner. There are two notable exceptions. Messrs. Bruce, Peebles, have struck out a line for themselves, in which the ideas of the foreigner are more in evidence than in the bulk of other British firms' exhibits, and on the other hand, the Brown-Boveri dynamo exhibited by Messrs. Richardson, Westgarth & Co. of Hartlepool, appears to combine the best of the English practice with the best of the Continental. Their apparatus is strongly made in every sense, yet there does not appear to be an ounce of metal wasted.

The exhibits show also that large machines have definitely settled down to the multipolar type. It is no longer a question between two poles, and many poles, after the machine has passed about 100 kilowatts, but how best to arrange the poles, and how to ensure that the best number will be employed.* There are, again, the two distinct lines of thought and design, that of lightness, comparatively, and high speeds, also comparatively, and comparatively heavy machines and low speeds, the former being represented principally by foreign makers, and the latter principally by British makers. The line is crossed, as usual, in both directions, by individual makers. Thus Messrs. Crompton and the Schuckert Co. each exhibit a dynamo directly coupled to a Willans engine, each running at 230 revolutions per minute., and each arranged to be capable of furnishing 550 volts and 1,320 ampères, and to furnish an overload of 50%, for a short time. Both sets are furnishing current for the supply service of the Exhibition, and though the load is not large enough properly to test their capabilities, as both have been purchased by the Corporation of Glasgow for their supply stations, there will be a chance of testing them in the only really practical way, in actual work. The differences in these two machines come out in the design, Crompton's being the heavier of the two. There are also several differences to be noted in the designs of different dynamos, though there is no marked line of cleavage, as in the other points, in the matter of the cores of the field magnets, and in the form of the brushes and holders. In all the multipolar machines, the field cores are assembled round the inside of a ring, which is sometimes of cast iron, sometimes of steel. Sometimes, again, the field-magnet cores are cast in one with the outer ring, as in the Schuckert referred to above, and in other cases they are made separately and bolted to the ring, as in the Mather and Platt machine. In a few cases, also, the field cores are laminated and cast into the ring, as in the Electric Manufacturing Co.'s machine. The brushes all follow one line up to a certain point. There are complete sets of brushes for each set of poles. No attempt is made, as in the case of some of the earlier multipolar machines, to collect from one set of brushes. This follows naturally from the large increase of current to be collected. The brushes themselves are all of carbon, with various methods of holding them, but all arranged for feeding radially towards the commutator segment, as they wear away. The actual form of the brushes, however, assumes two distinct lines. In one, the brush is split up into a number of small brushes, as many as fifteen being used for one set for each pole in the large Schuckert machine. In the other, the brushes are in the form of much larger carbon blocks, with consequently a smaller number of them. The method of holding them varies also. In the Schuckert machine referred to above, each of the fifteen carbons is held independently in its own shoe, with a spring attachment to keep it pressed on to the commutator, and the whole of the shoe and its attachments are made of aluminium, except the spring, the fifteen sets being merely strung on one brush spindle. With the four blocks, as in the Crompton machine, the whole is held in a somewhat massive brass bracket, carried by the field magnet ring, spring arrangements being fitted on the inner side of this. Messrs. Mather and Platt have adopted the aluminium form of brush-holder divided up, as the Schuckert, while in the Brown-Boveri the Crompton pattern has been adopted, or at any rate they are alike, and The English Manufacturing Co., of Preston, who exhibit a 500-kilo-watt dynamo of the multipolar type adopt the same pattern.

Another feature that may be noted is that the position which aluminium has won is fully recognised. Apparatus of different kinds are exhibited, made of aluminium, and in addition the brush-holders mentioned above, the field-magnet coil ends of dynamos, the outer cases of enclosed motors in some cases, and, in particular, the only arc lamps that are used for lighting a portion of the grounds (the remainder of the grounds being lighted by gas) are supplied with current by

* The multi-pole idea, in design, is working down, many small motors being made on these lines.

means of ¼-in. aluminium wires carried on poles.

THE ARRANGEMENT OF THE SUPPLY CABLES FOR ELECTRIC LIGHT AND POWER.

Perhaps one cannot close this instalment of the description of the apparatus shown better than by a *résumé* of the wiring arrangements. It should be mentioned that it would be difficult to speak too highly of the whole of the lighting of the Exhibition. It forms the very best example of lighting of public buildings and grounds the present writer remembers to have seen during the past twenty-five years, and this applies equally to both gas and electric light. It is impossible to find any place in the Exhibition, or in the grounds, that is not brilliantly lighted. There has been a fine contest between gas and electricity, and the honours are very fairly divided. The writer hopes to deal fully, in a later article, with the claim by gas that it is better and cheaper than electricity. He made some very careful measurements both as to power and as to purity. At present we are concerned with the electrical portion only, and again it would be difficult to praise the arrangements too highly. The electric light is pleasant and flexible, but it has an awkward reputation, unfortunately only too well earned, for selling its users, and when one finds that every humanly possible precaution was taken by those who have laid out the arrangements, one recognises that the work has been done by engineers who were possessed of skill and experience. The work has been done virtually, both in gas and electricity, by the Corporation officials. In the arrangements for delivering electric current, Mr. Wall, the Chief Superintendent of Mains for the Corporation, had charge of the whole matter, and it is under his supervision that the supply service has been organised, and the necessary arrangements made. In the lighting of the main building the very best arc lamp in the market has been used, the Brockie-Pell. At least three times the number are employed that would do the work, if it was a matter of ordinary factory lighting, so that if two-thirds of the lamps happened to go out, it would not matter so far as the practical lighting is concerned. This may be seen at night, when the Exhibition is closing. The lamps are turned out in batches, and still there is always plenty of light for everyone to get about. It is not so brilliant as before, but that is all. The arc lamps are also arranged on a large number of different circuits, adjacent lamps being fed from different supply circuits, so that in case of a fault in any one circuit, only a small portion of the lighting would be affected, not noticeable to inexpert eyes. The current from the different generators in the Machinery Hall is brought to the main switchboard, a drawing of which is shown on page 253, and from there it is distributed to five sub-switchboards in different parts of the building, and from each board 12 circuits are fed, each circuit consisting of 10 arc lamps, connected in series, the total number of arc lamps, including those in the grounds, being 1,050. The plant in the Machinery Hall is used to supply the lighting and power service inside the building, but a connection is made with the Corporation supply service at each of the five sub-switchboards mentioned above, so that if anything happens to the generators, or the inside service generally, the Corporation comes in at once to keep things going. And this is done after the generators in the Machinery Hall shut down in the evening. The whole of the lights in the grounds, including the arc lamps in one of the avenues, those in the refreshment kiosks, which employ a good many, and the whole of the incandescent lamps outside of the main buildings, those in the Art Gallery (4,000), those in the different buildings in the grounds, as well as the power service in the grounds, are supplied directly from the Corporation service. In this also the electrical engineers of the Corporation have shown the care and forethought that experience dictates. As will be seen from the accompanying plan, for which the writer is indebted to Mr. Wall, there are practically three chances against breakdown of lights

DIAGRAM OF DISTRIBUTORS AND FEEDERS, GLASGOW EXHIBITION.

in the grounds by the breakdown of a cable. There are two feeding points from which the supply of current is taken, one in Dumbarton Road, just outside the Exhibition, on the south side, and the other on Gilmore Hill, near the University, on the north side, the lights for the two portions of the grounds being taken from these two points. But, in addition, there is a cable passing right across the grounds, connecting the two feeding points, so that feeding can be carried on from either. In addition to this, for the avenue known as Machinery Street, from the fact that it consists of pavilions devoted to machinery, there is another connection arranged to be used in case of necessity, the cables from the two sides meeting at a junction point, so that the supply for that portion of the grounds is practically assured. For the power service, inside the Machinery Hall, two ring mains are fixed each passing right round the hall, each supplied by substantial feeder cables in the neighbourhood of the switchboard.

All the electrical supply in the Exhibition is on the three-wire system, the pressure between the outers being 500 volts. Consumers are supplied with current at 250 or at 500 volts, the arc lighting is worked at 500 volts and the incandescent lighting at 250 volts.

The whole of the wiring is on the triple concentric system. All the Corporation mains are on Callender's system, triple concentric, placed in wooden troughs and filled in with pitch. The main cables inside the building are of the British Insulated Wire Co.'s make, paper insulation; the arc lighting cables from the sub-switchboards are by Messrs. Isidor, Frankenburg, of Manchester—they are insulated with indiarubber.

The generating plant will be described in the next article. It should be mentioned here that in the generating plant, two things have been attained: it is fully representative of large continuous-current 500-volt and 250-volt machines, and it is so arranged that it is not easy for a breakdown to occur. There are many times more power than are required, and Mr. Wall arranges that each portion of the plant takes duty in turn, so that all are kept up to full working efficiency.

The Exhibition has been treated as a fair-sized town, given to forming crowds; and when it is remembered that on one Saturday there were 100,000 persons in the buildings and the grounds, the bulk of whom had to be safely got out at closing time, the provision strikes one as wise.

SYDNEY F. WALKER.

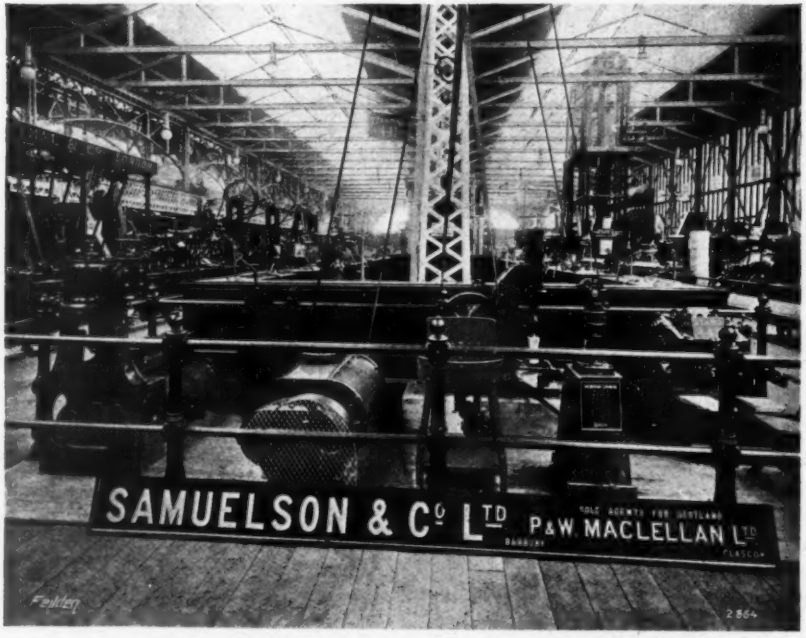
Glasgow International Exhibition.

By OUR SPECIAL COMMISSIONERS

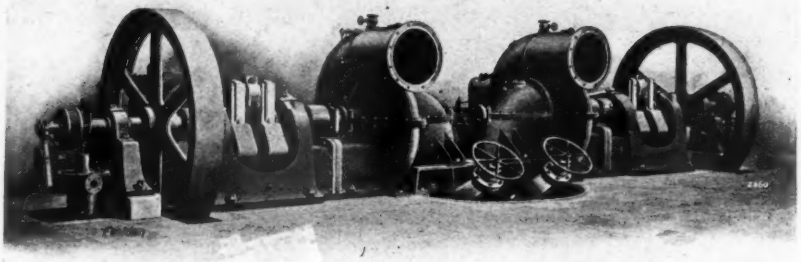
IV.

DAVID COLVILLE & SONS.

ONE of the most prominent exhibits is that of Messrs. David Colville & Sons, of the Dalzell Steel and Iron Works, Motherwell, whose immense curved plates arching upwards towards the roof at once attract the eye as you enter the Machinery Hall from the Grand Avenue. There are two of those mammoth arches, the one over the other at right angles, and beneath them is grouped a large collection of castings, ingots, slabs, bars, flats, rounds, and angles, illustrating the quality of the steel under various tests, hot and cold. It is impossible to deal here with all the items, but we note (all of Dalzell steel) a plate 72 ft. 6 ins. long by 74 ins. wide by $\frac{7}{8}$ in. thick, to Lloyd's tests; a plate, 65 ins. long by 74 ins. wide by $\frac{15}{16}$ in. thick, also to Lloyd's tests; a boiler shell plate,



MESSRS. SAMUELSON AND CO.'S EXHIBIT.



MESSRS. TANGYES' EXHIBIT: PUMPING PLANT FOR THE SWANSEA HARBOUR TRUST.

25 ft. long by 138 ins. wide by 1½ in. thick, to Lloyd's and Board of Trade tests; a boiler end plate, 11 ft. 7 ins. diameter by 1 3/16 ins. thick, to Lloyd's and Board of Trade tests; a flanged boiler end plate for 15-ft. diameter boiler; cross-connection pieces for Babcock-Wilcox water-tube boiler; a cogged slab, 7 ft. long by 54 ins. wide by 13 ins. thick, weighing 7 tons 11 cwts.; a cogged bloom, 21 ins. by 21 ins.; a cast-steel plate-mill roll, 34 ins. diameter by 12 ft. long, weighing 18 tons; a cast-steel bar mill roughing roll for 32-in. mill; and two Dalzell cast-steel mill pinions, one for 36-in. and one for 18-in. mill. The high quality of the steel is demonstrated in innumerable examples of twists, bends, bursts, elongations, and holing.

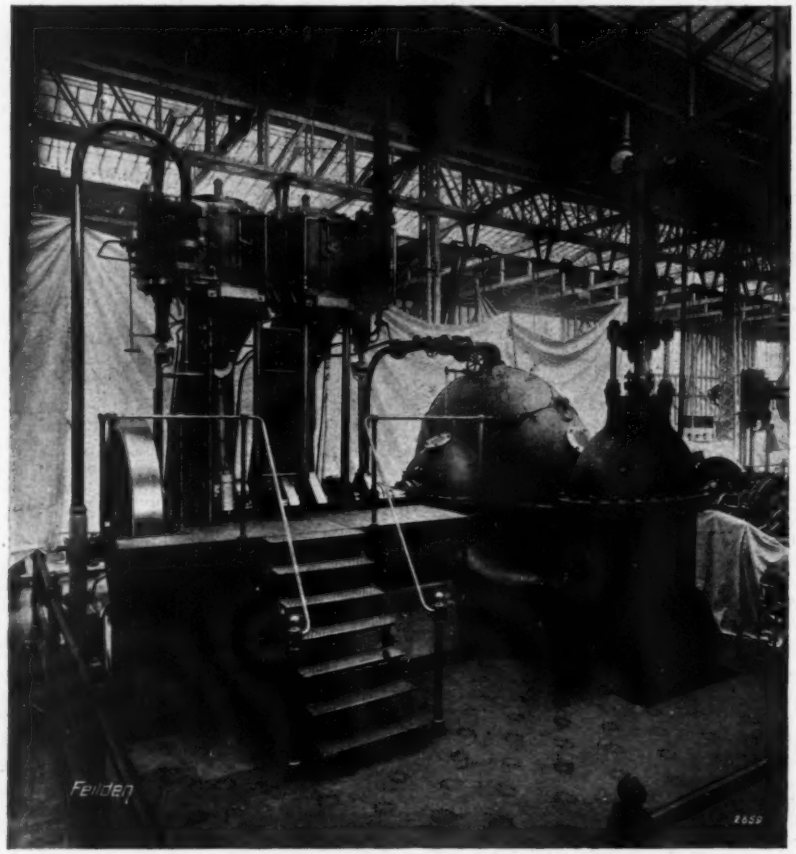
MESSRS. SAMUELSON & CO., Ltd., BANBURY.

Messrs. Samuelson & Co., Ltd., Britannia Works, Banbury, have a notable display of moulding machines, blowers, power hammers, etc. Their moulding machine for foundry use consists of two vertical columns resting on a bed-plate, the distance between the columns being capable of adjustment according to the size of the pattern plate. In the columns are two spindles, which carry the pattern-plate in bearings. These spindles are telescoped up and down the columns by means of a hand lever, and the pattern-plate can be turned completely round in its bearings. Underneath is a table running on rollers. The moulding boxes can be firmly attached to the pattern-plate by means of collars, or wing-bolts. The bottom box is first fixed to the plate and the sand rammed up; the whole is then turned completely over and the box lowered until it rests upon the table. The plate is then unfastened from the box and fixed in its bearings by the set-screws in top of the column, and, by means of the hand lever, raised from the mould, giving it at the same time a few gentle raps as it leaves the sand to prevent any clogging. The process of moulding the top is exactly the same as for the bottom, taking, of course, the impression from the other side of the plate. This accurate perpendicular lift prevents the breaking off of the corners or the cracking of the sand, and completely avoids the application of water and the mending up of the mould.

Well worth attention, too, is Samuelson & Co.'s new patent "Acme" blower and duplex engine combined, manufactured under Root's latest patents, 1885 and 1889, which is simpler than any other blower because it has fewer parts externally and internally. It is constructed entirely of metal, and will not shrink or swell; it will pass damp, hot or cold air, or dust without injury. The internal parts consist of two revolvers fitted with steel spindles, each revolver being cast

entire in one piece, without bolts, screws, nuts, etc., to get loose or cause trouble or injury. All the parts are interchangeable, and the mechanical construction is of the highest order.

The Samuelson & Longworth patent power hammer shown by this firm is made in three varieties, viz., with short strokes to run at high speeds, in sizes from ½ cwt. to 7 cwts., suitable for file forging, forging, in dies, table-blade making, sword making, skelping scythes, fork drawing, steel tilting, spade and shovel plating, boiler plate welding, etc., with long strokes to run at moderate speeds in sizes from ½ cwt. to 7 cwts., suitable for general smith work, stamping, etc.; with short strokes to run at high speeds, in sizes from 10 lbs. to 50 lbs., for planishing copper, sheet metal, etc. The first two are shown by a single standard hammer suitable for general forging, tube welding, etc., and a riveting hammer specially suitable for riveting cycle chains, light malleable iron, etc. The advantages claimed for the



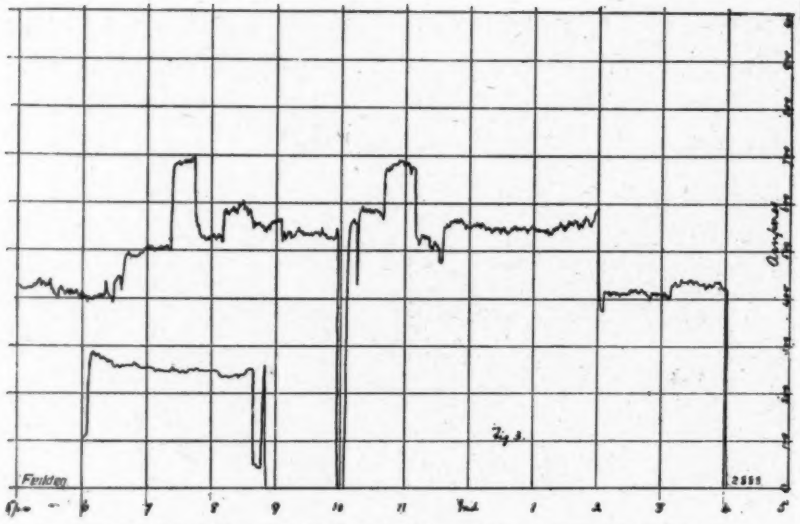
MESSRS. TANGYES' EXHIBIT: ONE-HALF OF PLANT FOR THE HEBBURN GRAVING-DOCK.

STAND OF MESSRS. ROYLES, LTD.

Samuelson & Longworth hammers over steam and other power hammers are that they are furnished with extra large belt pulleys, and can be driven from any ordinary line of shafting or direct by a steam, water, gas, or electric motor. They occupy no more floor space than a steam hammer. When the Longworth hammer is started the pallets do not strike each other, but keep a suitable distance apart, working on an air cushion, which allows the work to be placed on any part of the pallet, or changed from one die to another, and also allows the blow or blows to be given immediately, or the hammer to cease at once from striking the work. By means of the foot or hand lever single blows can be given, or a repetition of blows of any required intensity can be immediately delivered. The change from heavy to light blows, and *vice versâ*, or to blows of any intermediate force, can be made instantaneously. The light blows are delivered at the same rate per minute as the heavy ones. The lighter blows are delivered with a certainty and regularity of force which the best steam hammer cannot surpass. The power required to drive the Longworth power hammer is less when striking light blows than when delivering heavy blows, although the rate of delivery per minute is the same in both cases. The Longworth power hammer has no brakes of any kind to wear away the parts and absorb the driving power. The actuating air cylinder is placed at a considerable distance from the tup of the hammer, and cannot become heated by immediate contact with the hot iron on the anvil.

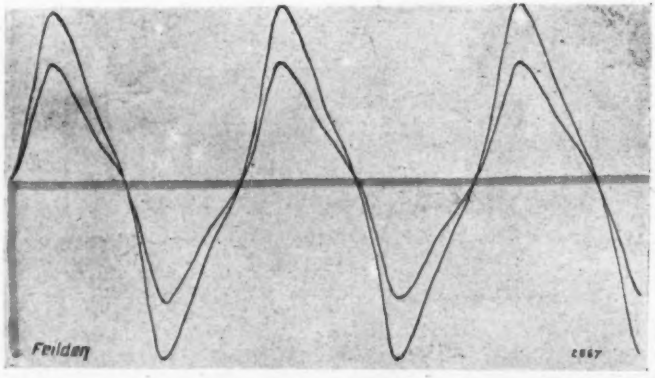
MESSRS. TANGYES, Ltd., CORNWALL WORKS, BIRMINGHAM.

Messrs. Tangyes, Limited, of Cornwall Works, Birmingham, and Hope Street, Glasgow, have a very interesting show. Their main exhibit is one of two engines and centrifugal pumps intended for the

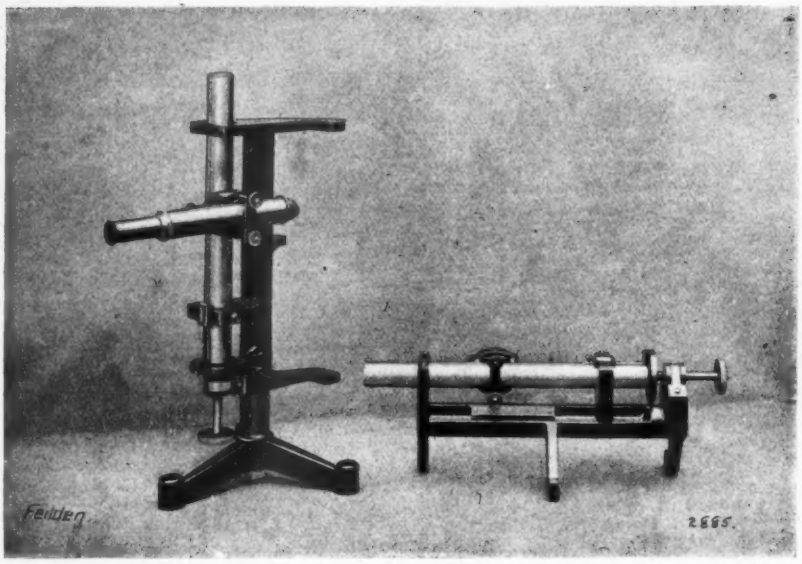


THE CAMBRIDGE SCIENTIFIC INSTRUMENT CO.: DIAGRAM SHOWING CURRENT CONSUMED BY AN ELECTRO-DEPOSITING PLANT, BY A CALLENDAR RECORDER ARRANGED AS A POTENTIOMETER

new graving-dock of Messrs. Robt. Stephenson & Co., Hebburn-on-Tyne. The engines are of the vertical compound type, 13½ ins. h.p. cylinder, 27 ins. l.p. cylinders by 20 ins. strokes, and are coupled direct on to the spindle of the centrifugal pumps. These latter have 45-in. suction and delivery pipes, and some idea of their size may be gathered from the fact that when working together the two pumps are capable of discharging 750,000 cub. ft. of water per hour. Another object of interest is a model (scale one inch to the foot) of two triple-expansion pumping engines now in course of construction for the Brede Valley Waterworks of the Hastings Corporation. The two engines which the model represents have steam cylinders 23¼ ins., 38 ins. and 62 ins. diameter by 48 ins. stroke, which drive on to treble rams 12½ ins. diameter by 48 ins. stroke. The bucket and plunger pumps for the wells, which are 280 ft.



CAMBRIDGE SCIENTIFIC INSTRUMENT CO.: CURVE OBTAINED FROM AN ALTERNATING CIRCUIT BY A DUDDELL OSCILLOGRAPH.

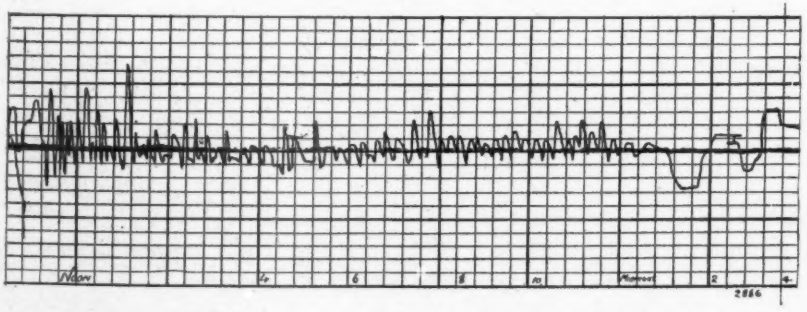


CAMBRIDGE SCIENTIFIC INSTRUMENT CO.: COMPARATOR FOR MEASURING ACCURATELY SMALL LENGTHS.

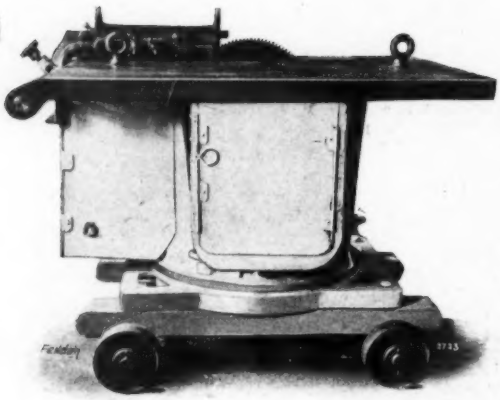
deep, are also provided. The ram pumps of each of these engines are to deliver 80,000 gals. of water per hour, and the well pumps 90,000 gals. per hour.

Part of a pumping plant for the Swansea Harbour Trust is also shown here. The two engines and pumps working at one time are capable of raising the level of water over the whole area of the Dock Old Lock and Basin 18 ins. in 5 hrs. under the conditions of tide shown on customer's drawing.

Each pumping set consists of one 26-in. centrifugal pump having a cast-iron casing and disc, and one 125-in. effective b.h.p. gas engine, running at 180 revolutions per minute, the crank-shaft fitted with cast-iron balanced weights, and the shaft on the fly-wheel side is carried in an outer diagonal chair. Each engine is fitted with



THE CAMBRIDGE SCIENTIFIC INSTRUMENT CO. DIAGRAM OBTAINED BY A CALLENDAR ELECTRIC RECORDER, SHOWING TEMPERATURE OBTAINED IN AN ANNEALING FURNACE.



THE SUNDERLAND FORGE AND ENGINEERING CO., LTD.: ELECTRICAL PORTABLE SAW BENCH FITTED WITH "PALLION" MOTOR, WHICH MAY BE SEEN WORKING AT MESSRS. JOHN MCDOWALL AND SON'S STAND.

a fly-wheel 102 ins. diam. by 13 ins. face. The crank-shaft is extended in each case beyond the outer bearing.

Messrs. Tangyes also show one of their well-known gas engines, which they make in various sizes up to 140 b.h.p. on the "Otto" principle and Pinkney's patents. This engine has a removable cylinder, liner, porcelain tube ignition, sensitive incline governor, mild steel crank-shaft running in long adjustable bearings, turned fly-wheel and pulley, wrought-iron connecting rod with adjustable bearings. machine-cut gear-wheels, steel side-shaft and machined cams. Each engine of this type is supplied with tank for cooling water, exhaust silencer, cast-iron combined gas-bag and anti-pulsator, one spare piston ring, one spare spring of each size used on the engine, three spare ignition tubes, a few asbestos chimney linings, washers for ends of ignition tubes, and a set of spanners. The following are its dimensions, etc.:—

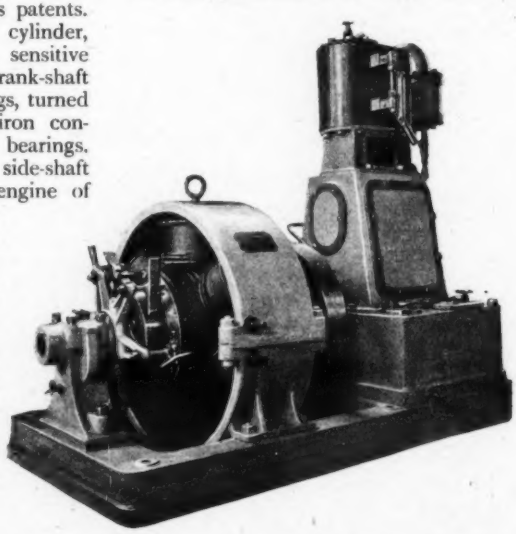
Effective brake horse-power...	3½
Maximum test brake horse-power	4
Maximum test indicated horse-power	4¾
Revolutions per minute ...	250
Driving pulley diameter ins.	12
,, ,, width ,,	7½
Fly-wheel diameter ... ,,	39
,, width ... ,,	4

The engines are tested to these powers with gas of 16·5 candle power.

ROYLES, LIMITED, MANCHESTER AND IRLAM.

This exhibit occupies a central position, is open on three sides to the main avenue, and contains many interesting specialities of a useful character in economising and utilising steam, gas, etc. There has been a thorough effort to lay before the public the many and varied apparatus manufactured by the firm, and, in addition to the extensive display of well-finished goods, there are fitted test apparatus under steam and water to demonstrate the actual advantages of the claims made.

The most extensive portion of the exhibit is devoted to the numerous and varied applications of Row's patent tube;

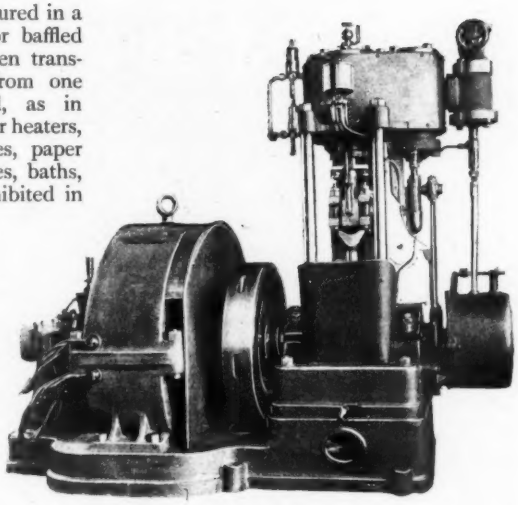


THE SUNDERLAND FORGE AND ENGINEERING CO., LTD.: "PALLION" COMBINED PLANT FOR SHIP LIGHTING. ENCLOSED SELF-LUBRICATING ENGINE COUPLED TO MULTIPOLAR OPEN-TYPE DYNAMO.

this invention has effectually secured in a simple manner the impinging or baffled surfaces, so highly desirable when transmitting heat through surfaces from one fluid or gas to another fluid, as in evaporators, condensers, feed-water heaters, calorifiers, batteries for breweries, paper mills, dye houses, sugar refineries, baths, etc. All these apparatus are exhibited in various forms of design to meet the exigencies of varying conditions of application, and demonstrate that this firm have given special study to this section of engineering.

Royle's patents are thoroughly well represented in the well-known Syphonia steam trap for high and low pressures, reducing valve for steam, surplus valves for steam, test pumps, gun-metal valves.

The exhibit as a whole is well displayed and in good taste, and is full of interest to many sections of the engineering world.



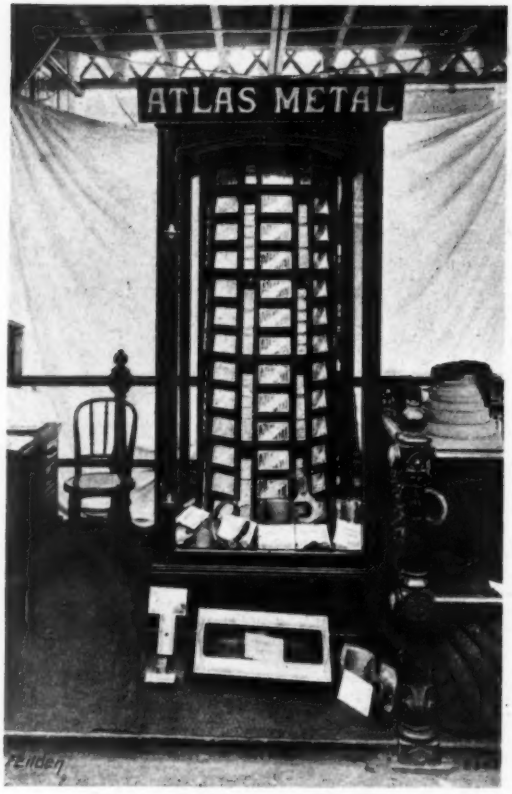
THE SUNDERLAND FORGE AND ENGINEERING CO., LTD.: "PALLION" COMBINED PLANT FOR SHIP LIGHTING. OPEN-TYPE ENGINE COUPLED TO OPEN-TYPE DYNAMO.

This firm have supplied four large feed-water heaters, together with valves, fittings, etc., for the electric power and lighting plant in the exhibition.

THE CAMBRIDGE SCIENTIFIC INSTRUMENT CO., LTD.

Many of the instruments exhibited by the Cambridge Scientific Instrument Co. are devoted to the measurement and elucidation of phenomena occurring in engineering practice, prominent among these being the instruments intended for the measurement of temperatures, especially high temperatures. The platinum resistance type of thermometer, designed and brought to perfection by Messrs. Callendar & Griffiths, is adopted. This instrument is undoubtedly the most accurate thermometer yet constructed. It has also the great advantage due to the arrangement of compensating leads, of allowing the thermometer to be used at considerable distances from the indicator or recorder. The temperature indicator has been especially designed for commercial use. It consists of a galvanometer and bridge so arranged that the temperature of the thermometer is read directly on the instrument. By means of this instrument any intelligent workman can measure the temperature of a furnace or other source of heat with a very high degree of accuracy. This type of indicator was employed by the Naval Boilers Committee of the Admiralty for the investigation of the behaviour of the Belleville boilers. The same instrument is equally suitable for measuring ordinary temperatures in inaccessible positions, such as the holds of ships, etc., and also very low temperatures, as in cold stores, refrigerators, etc. One of the great features of this instrument is its extreme portability —weight 11 lbs., height 10 ins., diameter 8 ins.

Callendar electric recorders are also shown. These instruments, when arranged as Wheatstone bridges, form an accurate means of measuring and recording temperatures. The figure on page 263 is a reproduction of a temperature obtained in an annealing furnace. The horizontal line is a temperature above 500 degs. Cent.



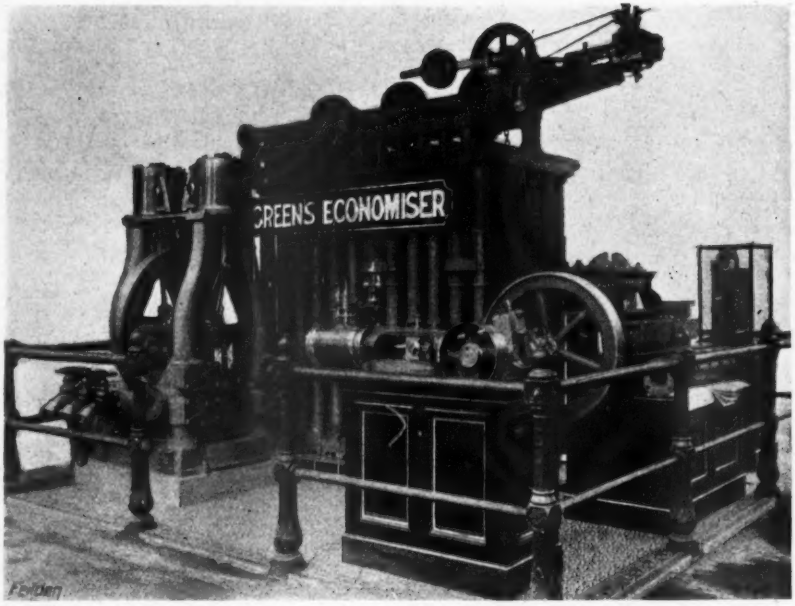
THE STAND OF THE ANTI-FRICTION ALLOYS CO., LTD.

(each division representing 4 degs. Cent.), at which the furnace man is supposed to maintain the furnace. It will thus be seen that by using this instrument, combined with careful stoking, the temperature was maintained within 20 degs. for over twelve hours. This instrument can be made to record practically any range of temperature up to 1,400 degs. Cent. (2,500 degs. Fahr.). It has been used with great success in a dust destructor, etc.

The Callendar recorder, when arranged as a potentiometer, can be used to record either currents or voltage, and possesses all the well-known advantages of the potentiometer method in point of accuracy. The figure on page 262 is a reproduction of a diagram, showing the current consumed by an electro depositing plant.

The Company also exhibits the Duddell oscillograph, an instrument especially designed for the study of the wave forms of alternating currents. This instrument, designed by Mr. W. Duddell, has put a powerful weapon of research into the hands of electrical engineers. It may be defined as an instrument whose deflection at any instant is proportional to the current flowing through it at that time, even if the current is varying rapidly. This instrument has the remarkably short periodic time of $\frac{1}{10,000}$th of a second, and is absolutely dead beat. The figure on page 262 is a reproduction of a photographic curve obtained from an alternating circuit, one wave form being the potential curve, the other the current. We may mention that the General Post Office has lately purchased one of these instruments for investigating the behaviour of Wheatstone automatic transmitters and other telegraphic apparatus.

Several of the instruments exhibited are for accurate length measurements, amongst others, a cathetometer, which is made on geometric principles throughout, and a spherometer for measuring the curvature of lenses. There is also an exceedingly useful instrument in the form of a comparator, the microscope of which is carried on a horizontal tube, which can be moved horizontally by means of a fine screw fitted with a micrometer head; a finely divided scale is also fitted in the eye-piece of the microscope, so that by this instrument small lengths can be measured up to an accuracy of ·001 mm. The figure on page 263 shows the instrument as adapted for both horizontal and vertical readings.



GREEN'S MODERN FUEL ECONOMISER EXHIBIT, STAND 554, MACHINERY HALL.

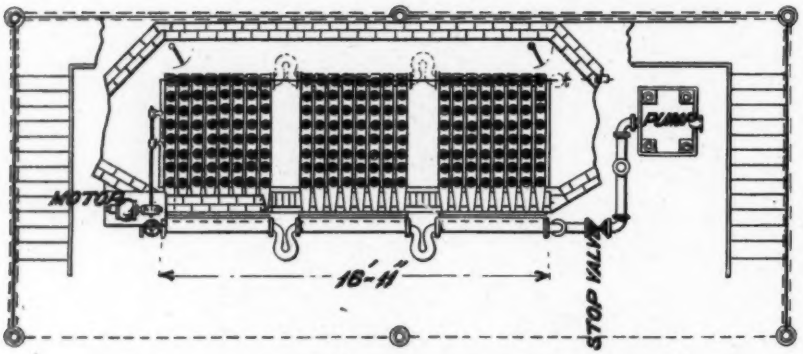
The extensometer, designed by Prof. Ewing, for measuring the extension of steel or iron specimens, is also exhibited.

By arrangement with Prof. Ayrton and Mr. Mather the Instrument Company are now the makers of their most recent type of moving coil galvanometers. These instruments are specially suitable for the test rooms in manufacturing works, as they are unaffected by the proximity of varying magnetic fields, dynamos, etc., and are also very little affected by mechanical vibration. They are, however, quite equal, if not superior, to the older types in point of sensibility.

MESSRS. DRYSDALE & CO.,

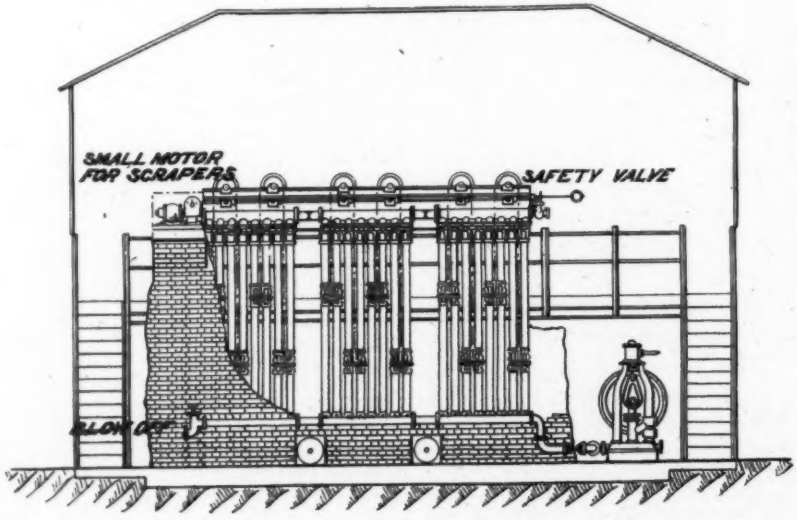
of the Bon Accord Engine Works, Glasgow, exhibit a high-speed engine, which has a cylinder 7½ ins. diameter by 7-in. stroke, and is suitable for running at a speed of 250 revolutions per minute. It is fitted with a Proell automatic crank shaft governor, and is driving direct a 16 b.h.p. four-pole Mavor & Coulson motor mounted on a self-contained bed-plate. There is also a set of two in series "Bon Accord" centrifugal pumps, driven direct by a small Lundell motor, all mounted on a self-contained bed-plate.

These pumps are made of aluminium; and the advantage of this type of pump (series) is that for a given height the speed is considerably less than would be the case where only one pump is used. Messrs. Drysdale also show an 8-in. direct-acting "Bon Accord" steam-driven pumping engine, the pump having large impeller for high lifts; a 4-ft. diameter "Bon Accord" steam fan engine for forced draught and ventilating purposes; a 5-in. "Bon Accord" direct-acting steam-driven pumping engine; and a belt-driven centrifugal pump. Some of the cylinders are covered with aluminium sheeting. Several of the engines are fitted with the firm's patent automatic crank pin bolts, which are self-adjusting and take up the wear of

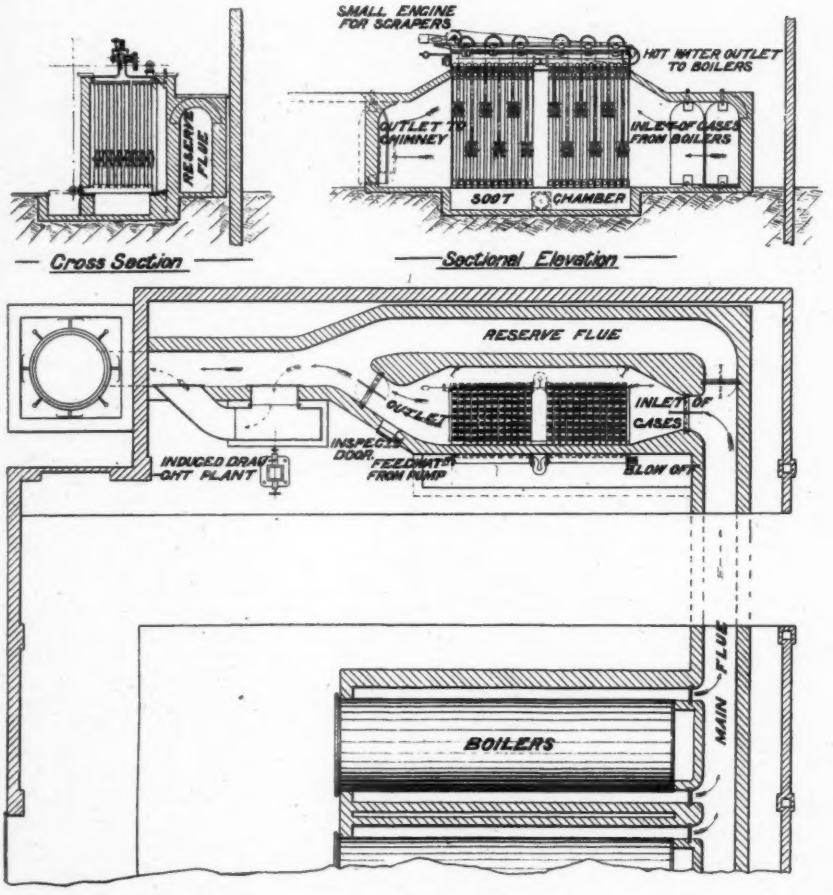


GROUND PLAN, GREEN'S MODERN FUEL ECONOMISER OF 192 TUBES IN THREE GROUPS, WITH FEED PUMP COUPLED UP: OUTSIDE PAVILION, NORTH GARDENS.

the brasses automatically, saving tear and wear, and rendering the engine practically noiseless. This arrangement consists of a round nut having a collar and a separate brass cap, inside of which is a coiled spring, one end coming through the cap and the other end made suitable for going through a catch in the reduced end of the bolt inside. Part of the nut projects inside the cap, and has a groove all round it. Through the groove are passed the split pins, which thus fasten the nut and cap together, while allowing them to revolve independently of one another. These nuts can be screwed on or off the bolts the same as ordinary nuts.



FRONT ELEVATION, GREEN'S MODERN FUEL ECONOMISER INSTALLATION, 192 TUBES IN THREE GROUPS: PAVILION, NORTH GARDENS.



GROUND PLAN.

GREEN'S MODERN FUEL ECONOMISER OF 192 TUBES INSTALLED WITH BATTERY OF LANCASHIRE BOILERS SUPPLYING POWER FOR ELECTRIC LIGHTING AND DRIVING.

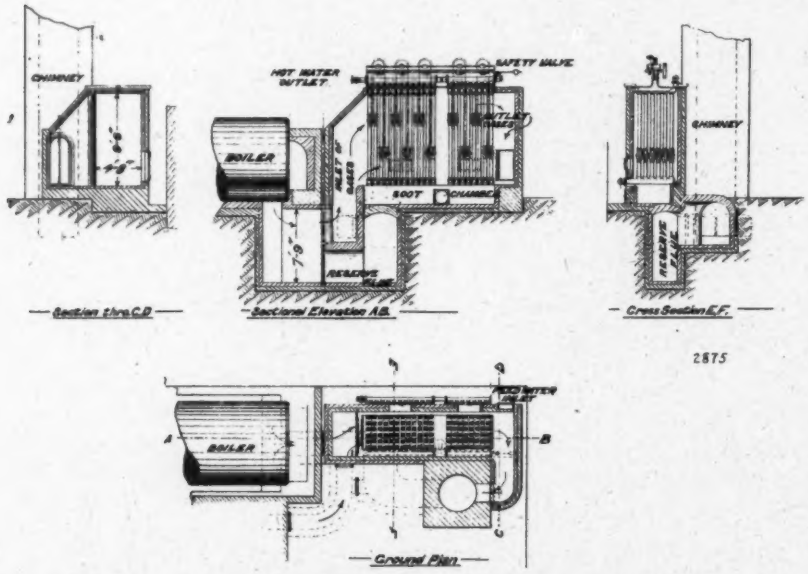
THE SUNDERLAND FORGE & ENGINEERING CO., LTD.

The exhibit of the Sunderland Forge and Engineering Co., Ltd., occupies Stand No. 539. This firm show two ship-lighting plants, an enclosed ventilated motor, and an electric winch. One engine is of their open type and direct-coupled to one of their "Pallion" multi-polar open type continuous-current compound-wound dynamos. This set is capable of an output of 65 amps. at 100 volts when running at 350 revolutions per minute, and with 80 lbs. of steam at the engine stop-valve. The governor is of their special throttling type, and controls the speed of the engine within two per cent. from no load to full load. The load can also be varied to any extent without necessitating any moving of the brushes.

The enclosed type of engine shown by this firm possesses the same type of governor as that mentioned above, and, in addition, is provided with a pump for lubricating the different parts of the engine under pressure. This engine is also coupled to a "Pallion" multipolar generator having an output of 99 amps. at 100 volts when running at a speed of 550 revolutions per minute with 80 lbs. of steam at the engine stop-valve.

and the field magnets revolve, but should the load on the barrel exceed a predetermined amount, the electric brake is arranged to slip and allow the barrel to stand and the armature to revolve. It will be seen that this arrangement takes up immediately any slack in the rope. This winch was specially designed for wharfage use.

There is alsc a nice collection of photographs showing amongst others an 80-kilo-



GREEN'S MODERN FUEL ECONOMISER OF 120 TUBES APPLIED TO DAVEY-PAXMAN BOILERS, SUPPLYING POWER FOR ELECTRIC LIGHTING THE EXHIBITION.

The "Pallion" motor exhibited on this stand is of the firm's latest design, and considerable attention has been paid to the accessibility of the various parts, to ventilation, and to obtaining fixed brushes. The motor shown is capable of developing 10 b.h.p. when running at about 650 revolutions per minute on a 200 volt circuit.

The electric winch embodies the novel principle of revolving both field magnets and armature. When working normally the armature is held by an electric brake

watt two-pole dynamo coupled direct to a central valve engine, five 400-h.p. tramway and lighting sets coupled to Belliss engines, portable winch suitable for use in shipyards, one of the firm's multipolar open type generators for belt driving, and a two-pole generator for belt driving.

This firm have also supplied the motor for running the wood-working machinery at Messrs. John McDowall & Sons' stand, where there is also to be seen running a portable electric saw bench suitable for shipyard work.

ANTI-FRICTION ALLOYS, LTD.,
52, Queen Victoria Street, E.C.

Some of the exhibitors have not been particularly fortunate in the positions allotted them. Dovetailed as they are between stands which should never have been admitted to the Machinery Hall, the above firm are probably one of the worst sufferers.

As one of the large manufacturers of anti-friction alloys of all descriptions, which they supply for home use and for export to all parts of the world, they have considered it most interesting to the public to exhibit, beside the unworked-up ingots of their manufactures, a number of pieces of machinery bearings actually lined with their metal. Many of these have been used, and carry with them a record of long and useful service, and many others are new, but are shown to illustrate the application of the metal for their particular purposes.

The following is a list of what they are exhibiting at the moment, which will shortly be increased by still more interesting specimens which cannot be delivered yet:—

Thrust shoe.
Neck bush.
One main bearing for large shaft.
Two wagon bearings, special construction.
Cylinder neck bush.
Slide valve.
Solid Atlas tramcar bearings.
Cast-iron car bearings, lined Atlas.
Pedestal bearings.
Road cable pulley (used).
" " " (new).

The lead which forms a component part of this alloy, and which replaces the tin used in other and more expensive metals, is claimed by the makers to in no way decrease its resistance to wear—a statement which, as far as it is possible to judge without making actual comparative tests, is well borne out by the specimens of old and worn bearings shown.

E. GREEN & SON, Ltd., MANCHESTER.

The exhibit of Green's Modern Fuel "Economiser," shown by Messrs. E. Green & Son, Ltd., Manchester and Wakefield, deserves fuller notice than we were able to give it in a previous article. In the Machinery Hall Messrs. Green & Son, Ltd., have an economiser of 72 tubes, suitable for small plant with one steam boiler, with a 3½-in. cylinder horizontal engine attached to the gearing frame for driving the scrapers; a 5-in. double-ram pump for feeding the economisers and steam boilers (which can also be utilised as a fire-pump); a 5-in. horizontal steam engine for driving economiser scrapers; specimen economiser castings, including vertical tubes burst at a pressure of over 3,000 lbs. per sq. in. In the North Gardens the firm have a special pavilion, in which is erected a larger size economiser, containing 192 tubes, arranged on the most modern principle in three groups, coupled together at top and bottom with expansion elbows, and with space at the back affording easy access to all parts of the apparatus. The scraper motion of this economiser is actuated by a 1-h.p. motor. This Economiser contains nearly 2,000 sq. ft. of heating surface. A 5-in. double-ram pump is coupled up to the apparatus to show the method of feeding. This firm give the use of a high-pressure Economiser, of 192 pipes in sections of eights, arranged in groups, to the Exhibition authorities, which is working in connection with the four Lancashire boilers supplying the power for driving the machinery plant in the Exhibition. The scrapers of this Economiser are worked with a small independent engine attached to the gearing frame. Also an Economiser of 120 pipes, in sections of sixes, arranged in two groups, which is working with a battery of Davey-Paxman boilers, which are supplying power for the electric light in the Exhibition. Both these Economisers are fitted with the usual blow-off and safety valves, and are constructed for boiler pressures of 200 lbs. to the square inch.

B. T.
C. E. A.

MACHINERY APPLIANCES AND PROCESSES

"Every part and side of our life, from the cradle to the grave, has been touched and tended by the inventor and manufacturer. His works are as numberless as the sands of the sea, but the onward rush of Science and the Arts opens up new fields of discovery and enterprise as each day dawns. Let us choose here and there among thousands, and in choosing take the best as far as in us lies."

A POWERFUL HEAVY TRAFFIC MOTOR.

THE self-propelled heavily-loaded vehicle which, dragging another bearing an almost equal load, is shown in our illustration, was built by Messrs. T. Coulthard & Co., Ltd., the well-known British engineering firm, whose headquarters are at Preston. This type of automotor has a length (over all) of 18 ft. 3 ins; a width (over all) of 6 ft. 6 ins.; a height over chimney of 8 ft. 10 ins.; a platform of 12 ft. 6 ins. by 6 ft. 6 ins., representing an area of 80 sq. ft. The capacity of the fuel bunker is sufficient for a run of 30 miles with a load of 4 cwts. The figures for fast and slow speeds are 5 and 2½ miles. Messrs. Coulthard & Co. guarantee these vehicles to ascend with perfect safety gradients up to 10 per cent. with a load of 5 tons. The construction of the vehicle is very solid and compact. The main frame is of channel steel, braced and constructed so as to carry the whole of the machinery, boiler and tanks, the frame itself being supported on the axles by long laminated springs. The boiler is of the improved vertical fire tube type, of which the firm makes a speciality, and provided with the most approved fittings. It is constructed for a working pressure of 200 lbs. per sq. in. and is inspected by the National Boiler Insurance Company, a policy of which Company, valid for twelve months, is presented by Messrs. Coulthard & Co. to their clients. The boiler feed pump is directly connected to the engine, and an independent steam pump is provided, to be used as feed pump in case of emergency. The engine is of the compound type and fitted with link-reversing gear. Both the engine and the various reduction and compensating gearing are contained in an oil and dirt-tight casing, and are suspended from the framework of the vehicle at three points, two of which are spherical bearings. By this

SELF-PROPELLED VEHICLE FOR HEAVY LOADS, BY MESSRS. T. COULTHARD AND CO., LTD., PRESTON.

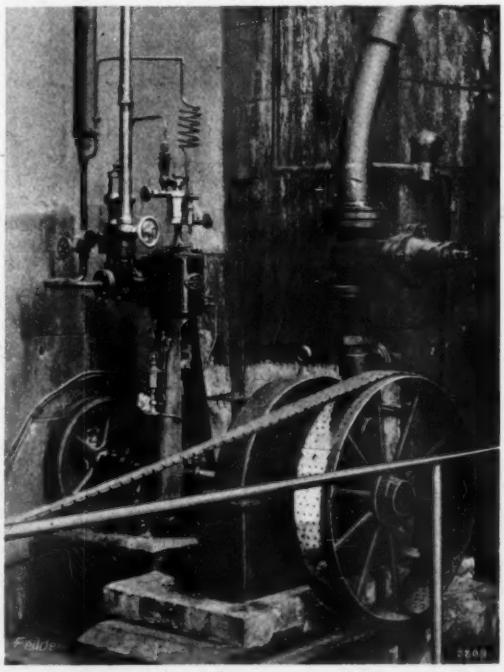
arrangement, coupled with Hans Renold's patent silent driving-chain, the greatest possible flexibility in the driving arrangement is obtained. Besides this, since the shafts are always in perfect alignment, it is not possible to get any cross wind or twist on them. The various handles for controlling the engines—*i.e.*, for steering, starting, reversing, and brakes, as well as the main steam-valve and boiler feed handles, are all in direct range of the driver. The wheels are of gun-carriage pattern, they are fitted with steel hub, oak spokes, and ash felloes, the width of tyres being 6 ins. and 5 ins., and they are provided with Messrs. Coulthard's triangular attachment, whereby the drive is taken directly to the wheel felloes. The main brakes are two-band brakes fitted to the road driving-wheels, and are capable of holding the vehicle even on the steepest gradient. The whole construction of the vehicle justifies the statement of the makers that their aim was to put a vehicle upon the market which would work well on a small expenditure for repairs and have a reasonably long life. Messrs. Coulthard & Co., moreover, undertake to renew any part of the vehicle which may fail or break within six months of delivery, unless, of course, such failure or breakage be due to neglect or improper usage.

As stated above, the vehicle described and represented in our illustration was guaranteed only for a maximum load of five tons. No better proof, however, of the fact that Messrs. Coulthard & Co., far from overstating the efficiency of their wagons, considerably understate it, can be given than the photograph, reproduced by us, which was sent to the makers by one of their clients, who has good reason to be delighted with his bargain. As the illustration shows, he has attached to the motor-wagon a travelling lorry, and is carrying, instead of a maximum of five tons, a total load of eight tons. This performance is a far more convincing advertisement for this well-known firm than would be the most eloquent enumeration of the various improvements distinguishing their work from that of other firms, and should suffice to show intending buyers where to get full value for their money.

COMBINED PELTON WHEEL AND STEAM ENGINE.

BUILT FOR CHESTER WATER WORKS CO.

A REMARKABLE combination of steam-engine and Pelton water-wheel is in successful operation at the Tower Water Works, Chester. It is used to drive dynamos for lighting the pumping station and filter beds, and so arranged that either the Pelton wheel or steam engine can be run separately or together, as required. The wheel is 3 ft. diameter, fitted with phosphor bronze buckets of approved shape, the sides of bucket being widened out to allow the spreading of the water as its velocity diminishes. The shaft is fitted with stuffing boxes to prevent the lubricating oil from mixing with the water. This is very important, as all the water is filtered and passes on to the town main. Two nozzles of $\frac{7}{8}$ in. diameter are fitted, but only one is generally required. The only other British installation of a similar nature



COMBINED PELTON WATER WHEEL AND STEAM ENGINE.

is the Linton and Lynmouth Electricity Works, Lynmouth, N. Devon. Here Pelton wheels and turbines are used alternately, the steam engines in this case, however, are only used in cases of emergency.

AN EFFICIENT ELECTRO-MAGNETIC SEPARATOR.

AMONG the electro-magnetic separators for extracting iron and steel from borings, ash-metals, powdered glass, or other alien substances with which they have become mixed, those constructed by Messrs. A. E. Gaskell & Co., Manchester, deserve special attention on account of their high output and practically automatic action, which permits the employment of skilled labour to be dispensed with. Their separators are constructed in two types, in both of which electro-magnets in place of permanent magnets are used. Type 1 is designed for the purpose of dealing with ordinary machine-shop turnings, borings and ash-metals in which there is a large percentage of iron or steel which it is desirable to separate from the brass, so that the latter may be obtained quite pure, and, after being molten and cast into ingots, show no streaks indicating the presence of iron in its composition. The material to be treated is fed into the hopper *A* (Fig. 1), and passes along the magnetising trough by the worm *B*, which is driven by means of cone pulleys actuated by spur gearing from the barrel spindle, rendering it possible to regulate the feed according to the character of the material under treatment. The revolving barrel *C* has the shape of a truncated hexagonal pyramid, the six magnetic faces of which carry an aggregate of 144 magnet pole tips, which are placed at such an angle as to work the material in the magnetising tray along the face of the barrel in a direction parallel to its axis. In this way the brass, freed from all admixture of iron, drops from the tray and is led away from the separator through a chute. The iron is held by magnetic attraction until the drum has completed the greater part of a full revolution, and a point just above the brush *D* is reached, when the current is suddenly cut off by means of the commutator *E*, and it is allowed to drop clear of the tray into a receptacle contained in the base of the machine. After each operation, moreover, the magnets are wiped off by the brush *D* above mentioned, so as to assure their absolute cleanliness before they are used for separating the metals in the next quantity of material to be treated. Type 2 is specially constructed for the treatment of large quantities of coarse material, and differs from the former both in form and in the method of working. This type of separator consists of a drum barrel, varying in size according to the capacity required, on to the

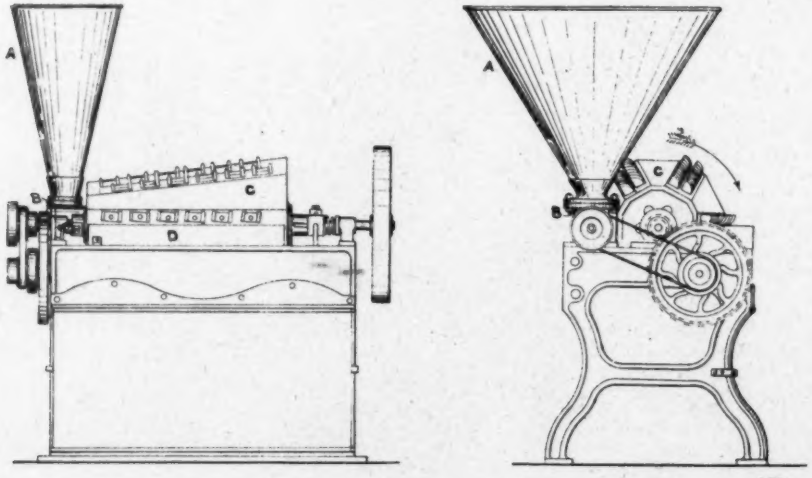
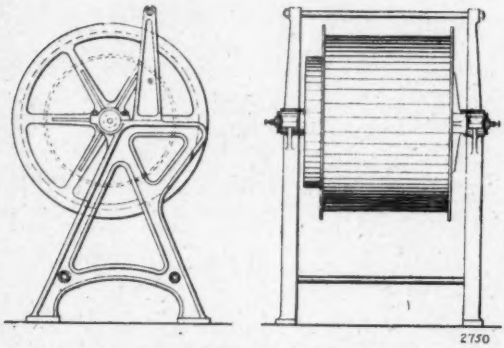


FIG. 1.—AN EFFICIENT ELECTRO-MAGNETIC SEPARATOR.



ELECTRO-MAGNETIC SEPARATOR FOR THE TREATMENT OF COARSE MATERIAL.

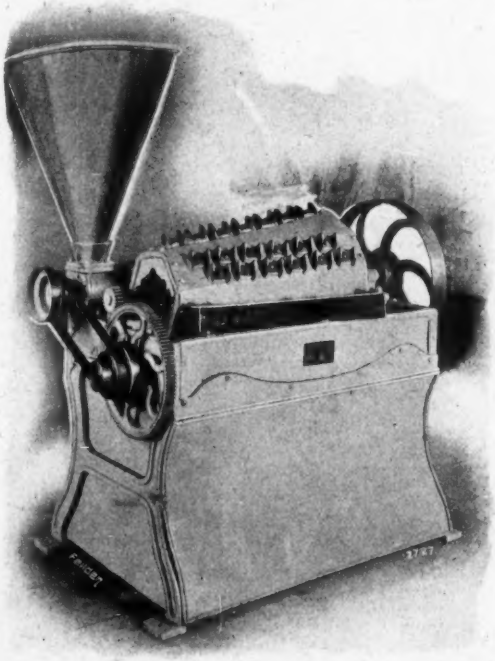
top of which the material is fed. It remains under magnetic influence throughout the revolution until it reaches a point at which the current is cut off, and the iron which has been clinging to the surface is automatically released.

The characteristic features in the electro-magnetic separators constructed by Messrs. Gaskell & Co. are, as the reader will see from the above description, the use of electro-magnets instead of permanent ones, and the automatic cut-off device rendered possible in consequence of the use of electro-magnets, by means of which demagnetisation is secured and the iron is much more easily released than from permanent magnets, which are cleaned only with difficulty. These features increase the output of the separator considerably, as stated in the beginning, and reduce the cost of operation, since no skilled labour is required to work the apparatus.

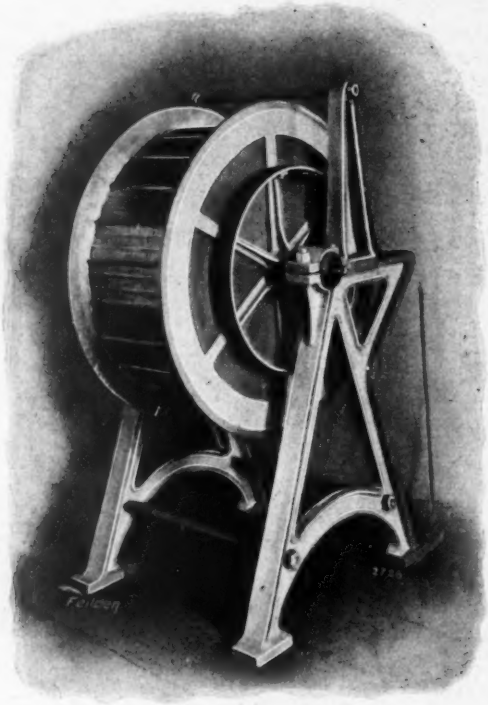
THE "NEW PREMIER" RAISING MACHINE.

THE raising of a nap or pile on textile fabrics is an operation that has been considered necessary from very early times, and although machines have been invented with a view to accomplish the object in a speedy and effective manner, none have hitherto met with entire acceptance by the trade. In the woollen and worsted branches the type of machine still in general use is the old teasle-gig, which, although slow in its operation, performs its functions in a satisfactory manner. There are numerous fabrics that are not only much improved in appearance by the soft, woolly surface imparted to them by the operation of raising, but their usefulness is increased.

The "New Premier" Raising Machine, invented by Mr. R. Sellers, of the firm of Joseph Sellers & Sons, card-clothing makers, Cleckheaton, Yorkshire, has been constructed upon principles that differ entirely from those of existing machines. The fact that a large number of sample cloths are prepared by hand by the aid of wire cards suggested the possibility of similar treatment by a



EXTERIOR VIEW OF ELECTRO-MAGNETIC SEPARATOR.



ELECTRO-MAGNETIC SEPARATOR FOR TREATMENT OF COARSE MATERIAL.

mechanical method. The result is an example of perfection in an invention which will have a great effect upon the textile industries, as it offers an effective method of giving a nap or raise to every class of fabric, many cloths which could not be dealt with having the finish applied to them.

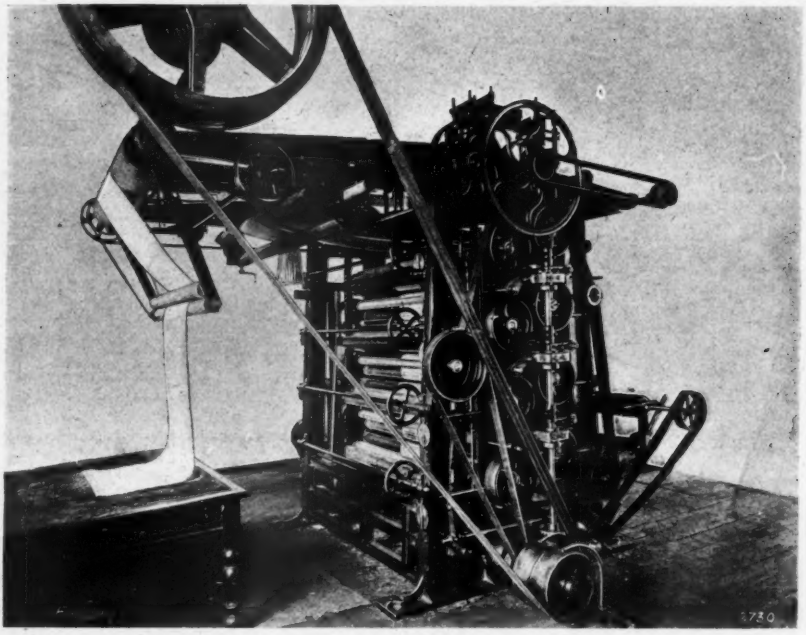
The illustration gives a view of a single machine for raising a nap on one side of the fabric only, but double machines operate upon one or both sides of the cloth simultaneously. The fabric to be raised enters over rollers from a batch upon the floor. It then passes downward round a series of rollers which hold it firmly in narrow planes, in order that no creases may appear in the cloth. A series of bars, hexagonal in cross section and covered with wire card-clothing, reciprocate vertically, at a great speed, immediately in front of the fabric. A number of cross-raising rollers reciprocate horizontally. The two sets of rollers may be applied together or separately, as desired. Another set of card-covered rollers, which rise and fall as they rotate, free the hexagonal rollers from flock, and also keep the teeth of the cards in a sharp condition. By an ingenious arrangement the reciprocating hexagonal rollers are caused to tip at required intervals, bringing clean flats into operation, and subjecting the remainder to the cleaning rollers in order. Thus there is a continual succession of clean flats presented to the fabric.

A dial plate, with figures and an index finger, is connected with each set of rollers for the purpose of showing the degree of raise or nap given to a fabric. By this means all guesswork is avoided, as, providing the operator books a certain "raise," the same can be obtained again by simply turning the hand-wheels—shown at the front of the illustration—until the index fingers point to the necessary figures.

The fabric, having travelled through the machine, is carried up the back and over the top until it reaches the cuttling device, where it is laid in folds.

The reciprocating rollers run up to 1,000 strokes per minute, at the same time gently working against the cloth, there being no tearing of the fibres. So mild is their action that lint for surgical purposes is raised upon the machine without any previous preparation. With such a system it follows in all cases that less flock is made, the saving being quite 75 per cent., a much better cloth therefore being possible. In a machine which operates upon both sides of the fabric simultaneously the same or a different nap may be given on each side, and the raising rollers may be brought in and out of contact with the fabric as desired; long or short naps, or a long nap on one side and a short one on the other, being given according to requirements.

The machine is particularly interesting to the woollen and worsted trades, as it performs its work not only much better, but quicker than under existing methods; and high-class, medium, or low cloths, including shoddy, can be treated with the best results. Scotch carpets have a nap given to them, whilst the colours are artistically blended, making a much improved floor covering. There is no limit to the usefulness of the machine, and its advantages in the point of



THE "NEW PREMIER" RAISING MACHINE.

saving are many. It produces as much work as four teasle-gigs, and only occupies the space of one. It does not narrow the goods, as does the old method, and in this respect there is a saving of 65 per cent. The cost of maintenance is not more than a tenth that of a teasle-gig, whilst in power the saving is 75 per cent.

The "New Premier" Raising Machine is one which will revolutionise the textile trades. The claims set forward have been amply demonstrated. The makers have a machine at work at Holmfield Mill, Thornton Road, Bradford, and a large number of manufacturers have fully tested it, many of them bringing their own cloths, in order that they might be better able to judge of its merits. With all the above advantages, the inventor claims to accomplish even more, as a machine is being built for Messrs. Thackrah & Co., Ravensthorpe, Yorkshire, which will do quite double the amount of work which the machine illustrated can perform, even when arranged as a double machine, raising both sides of the fabric.

The machine is being put on the market by the "New Premier" Raising Machine Syndicate, Ltd., 12, Swan Arcade, Bradford.

LATHE FOR TURNING BOSSES, COLLARS, &c.

THE illustrations on page 278 show a new lathe recently put on the market by Mr. J. Parkinson, Canal Ironworks, Shipley, for turning cast iron or brass bosses, hoops, collars, or similar pieces.

Fig. 1 shows what is practically a bird's-eye view of the machine, and indicates the position of the cutting tools used. Fig. 2 shows a front view of the machine.

The fast headstock spindle is driven by a wide belt single pulley, and in place of the usual loose or poppet headstock is a revolving spindle carried on a slide, which may be quickly set in or out by means of a rack and pinion, and the weighted lever shown. The pieces to be turned are gripped on expanding bushes, operated by a draw-back rod passing

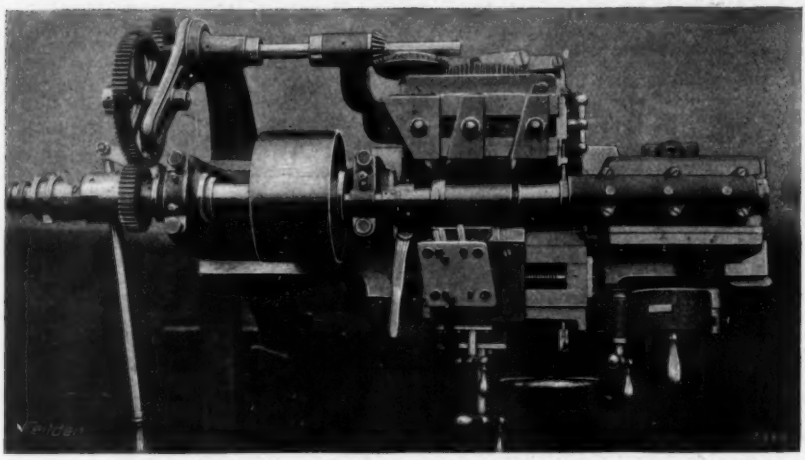


FIG. 1.—LATHE FOR TURNING BOSSES, COLLARS, ETC. VIEW SHOWING CASTING IN POSITION AND CUTTERS.

through the live spindle, and a toggle arrangement as generally used in screw machines. The outer end of the draw-back rod is tapered to fit in the revolving spindle, which takes the place of the poppet. The rod and expanding bush are thus positively driven and rigidly supported at both ends. In the lathe seven cutters are in operation for turning a cast-iron boss to the dimensions shown in Fig. 3, viz., three cutters on a rest at the front side of the lathe for sliding, and four on a rest at the

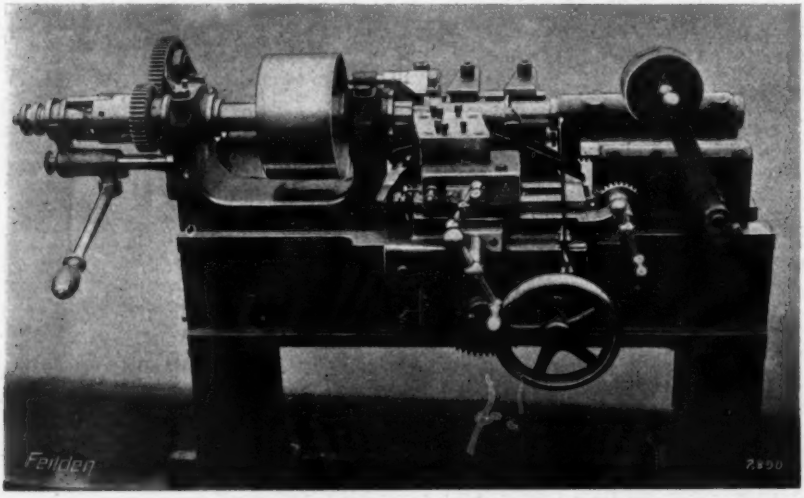


FIG. 2.—FRONT VIEW OF LATHE FOR TURNING BOSSES, COLLARS, ETC.

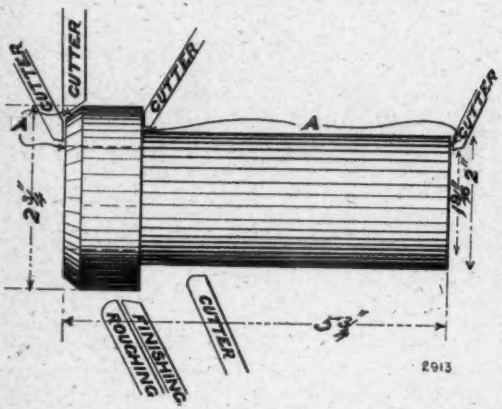


FIG. 3.—CAST-IRON BOSS MACHINED IN THREE MINUTES ON MR. J. PARKINSON'S NEW LATHE.

back for ending, chamfering, &c. Both cutter rests have power feeds and automatic stops.

The lathe operates as follows:—While the spindle is revolving, one of the rough pieces to be turned is slipped on the expanding bush against a stop to limit the end movement, and gripped by the hole. The cutters on the front rest are started cutting, and those on the back rest commence travelling towards the lathe centres, turning the boss at the parts marked *A* in Fig. 3. These cutters cease action before the two leading cutters on the front slide commence to cut on the collar of the piece being turned, and as soon as these two cutters are across the collar the work is finished. The cutter slides are withdrawn by the screws, the poppet head revolving spindle is run back, the finished article is removed and another substituted, the lathe running continuously the whole of the time.

The actual cutting time on a casting of the dimensions indicated in Fig. 3 was timed by our representative at three minutes; hence, in addition to the facts that ordinary cutters are used and that the cost of maintaining them is small, a very large output may be maintained.

The Editor or a representative will be pleased to inspect any new machinery for the purpose of describing same in this section.

AN IMPROVED HEATING BOILER.

THE accompanying illustrations show details of a new heating boiler for providing an independent hot water supply, now being manufactured by Messrs. Hartley & Sugden, Ltd., Atlas Works, Halifax.

It is constructed throughout of wrought iron plates, and virtually consists of two portions, one of which may be closed off when necessary, thus effecting a saving in fuel during the spring and autumn periods.

The course taken by the flames and hot gases is distinctly shown in the figure, from which it will also be seen that vertical water tubes run from the top to the bottom of the boiler, thus securing a large heating surface and a vigorous and unimpeded circulation of the water.

The arrangement of the water-tubes and water-ways is such, moreover, as to permit any sediment to fall below the level of the fire-bars, thus facilitating its easy removal.

The boiler, which is arranged to be fixed without brickwork, has a very neat external appearance, and altogether is well adapted for the purpose for which it has been designed.

IMPROVED HEATING BOILER BY MESSRS. HARTLEY AND SUGDEN, LTD.

WORKSHOP PRACTICE

Practical suggestions for this section are invited, which, if accepted, will be suitably paid for. Wherever possible, drawings should accompany the contribution; rough sketches will suffice. Nothing will be too poor for a careful inspection.

I.—ELECTRICAL ENGINEERING.

Cooling a Hot Bearing with Water in the middle of the night, and its Results.—It was a plant at a colliery, arranged as plants ought not to be. Two continuous-current generators were driven by one engine, through the medium of a countershaft, the engine being at one end of the engine-house in the middle of that end, and the two dynamos at the other end, one on each side. It was in the wee sma' hours, and the attendant was thinking deeply, as attendants are apt to at that time of day. Suddenly he was aroused out of his reverie by a noise—one of those noises which every engineer knows, and fears—it meant that a bearing was hot, and very hot. He jumped up quickly, and his first impulse was to cool the bearing in the readiest manner, which, in the condition in which his reverie had left him, was by pouring the contents of a bucket of water, which happened to be handy, over the bearing. The next thing he knew was that the belts were flying all round him, and things were not what they seemed, or had appeared to be in his reverie, and the result was he had to shut down while he repaired matters.

The Result of Penny Wisdom. A Dynamo practically wrecked when it had only worked for half its Life.—It was one of those cases one so often meets with. The younger branches of a firm whose name is almost world-wide in a particular business, thought there was an opening for an enterprising firm to capture some of the business of certain firms in another branch of business, which was closely allied to their own. A most beautiful factory was put up, with plenty of room for extensions, and everthing ready for the large trade when it came. But in one important point the usual pennyworth of tar was missing. The factory, necessarily, was lighted by electric light, and one or two small motors were also put in, but it was arranged to drive the main dynamo—there were two, one to take the bulk of the load, and the other to act as an auxiliary—from the main engine which was driving the rest of the works, and further it was arranged to drive by a belt very nearly vertical, from a countershaft overhead. The arrangement was very inconvenient and very wasteful, as it was never allowable to stop the main engine to put the belt on the dynamo except in the dinner-hour, or some similar time, and consequently the machine was often running without the brushes on for hours together, ready for the time when it might be required. The driving belt, as will be understood, was obliged to be kept very tight, and the consequence was that the bearing of the machine at the pulley end wore very fast, so that after the machine had been installed a short time, it began to give continual trouble. The armature would sometimes run when the brushes were not down, perfectly clear of the poles, notwithstanding the pull of the driving belt, but immediately the brushes were put down trouble commenced, the armature conductors rubbing on the poles, and other troubles. The pull of the driving belt having caused the bearing at that end to wear, the armature was pulled towards with that pole—it was a two-pole-dynamo, the armature above the field magnets

—but when it was running without the brushes down, the part of the armature which was less in diameter was opposite the ends of the pole pieces, and so ran clear, but when the brushes were put down the armature was pulled in to the polar space, and the end portion where the conductors were higher, owing to their having to cross over, came within polar space, and occasionally rubbed. It was found also, as was natural, that the severe pull of the belt, as described, had twisted the spindle slightly, so that the whole thing had to be remade. The arrangement was a striking instance of penny wisdom in every way. After spending the large amount on the building, and ground, space was grudged for a longer drive from the countershaft, which would have improved matters, and money was grudged for an engine for a separate drive, and even for a clutch to enable the engineer to have some sort of control over the plant, though the inconvenience caused by these things was costing the firm the interest on treble their value.

Oil and Dirt Stop a Dynamo from Working.—This is another case so often met with. A continuous current machine had been running for some years, furnishing lights for a factory, and had done its work very well, till the time came to change the armature, while a new commutator was fitted to the armature which had been running. Then, when the new armature was inserted and all connected up, it positively refused to furnish any current at all. It was known that the new armature was in proper order, as it had been tried in a similar machine, and everything had been apparently cleaned on the body of the machine, but still it refused to build up. It was re-magnetised, it being thought that a trick which is often played by dynamos was being played in this case, that the machine had lost its magnetism from being pulled about in the process of taking the armature out, the connections having to be disarranged, and the field magnet bars to be pulled about a good bit. No result followed the re-magnetising, though a small pressure was obtainable if the machine was run while the exciting current was on. Finally the trouble was traced to the brush holders, though they had been gone over several times, and the cause to a film of oil which had formed on the spindles and which had apparently been removed by the cleaning which had been done. The brush shoes were practically insulated from the brush spindles, or at least the resistance between these was so high that the critical current to start the magnetism would not pass. When the spindles were subject to an extra special cleaning, particularly directed to the removal of the film of oil, and the dirt which had bedded on it, the machine built up, and gave no further trouble.

A Case somewhat similar to the Above.—In this case the dynamo had been taken to pieces for convenience in transport, and when put together again refused to build up. It was carefully tested, it being feared that the armature had got damaged in transit, but all was found to be in order. Eventually the trouble was again located in the film of dirt which had formed between the brush spindle and the brush shoe. It was discovered quite accidentally what the trouble was, after many hours had been spent uselessly on the matter; and it was discovered in the way these troubles so frequently are, by feeling all over everything with the hand, tightening here, and loosening there, and so on. It goes without saying that the machine was furnishing low-tension current, 100 volts in each case. Feeling around would not do with high tensions.

Some Notes on the Operation of Electric Traction Plants.—The operation of traction plant is simpler than that of lighting plant. The bus-bar voltage, with traction plant, in many stations varies as much as 50 volts without inconvenience, while interruptions of the supply for less than a minute, and a drop of pressure of as much as 200 volts for a few seconds, does not matter. It is not noticed by the outside staff, and the using public do not know anything about it. With lighting these variations and the intermissions would produce letters to the local papers, and all sorts of other troubles.

There are several points in which the operation of traction plants differs from that of lighting plant, apart from the liberties that can be taken with the supply and the pressure.

For instance, when an additional unit shall be put on, and of what capacity it shall be. In both lighting and traction this is generally obtained from the log, but the following are exceptional cases, not reported in the log. In a certain station a 500-h.p. set was running on the day load, and about noon the load increased suddenly far above the usual; it was, in fact, repeatedly overloading the engine, as much as it was wise to allow the engine to carry. This had been going on for half-an-hour, and another

engine was ready to go in, when the load suddenly shot up, so that in a few seconds the pressure was down to 300 volts. The feeder circuit breaker and feeder switch were both thrown, the operation occupying 30 secs., by which time the pressure was normal again. The feeder was switched on again, and the engine ran alone till the evening, taking all the load that came. The outside department had put on more cars and forgotten to notify the station. The engine was of the high-speed type

On a continuous-current lighting load it is usual to run all feeders at low volts, rather than put a district out. Had this practice been followed in the above case, the pressure would have been low for the time which would have been occupied in getting the second machine connected, and afterwards the two machines would have been running to perform the work which one performed quite well for the remainder of the day.

The same effect is also observed when temporary short circuits are formed by the weather, and also when several cars start together; or when, from any cause, the pressure at the cars has dropped below a certain figure, when the car-drivers take more and more current till they overpower the engine. With motor-work the current increases as the voltage drops, and the engine requires a substantial relief, once it has started to pull up, before it can recover itself. For this reason it is wiser to choose the most heavily-loaded feeder to disconnect when a case of this kind occurs.

The same thing is observed on a lighting circuit which has many shunt motors on. The shunt motor keeps approximately constant speed on varying voltage, if the load on the motors is constant; the current will increase as the voltage drops, if the machine is to do the same work.

There seems to be a tendency to put circuit breakers back an insufficient number of times. This is especially so in small stations, where a note is made in the log, and the circuit is kept open for five minutes. The following are typical cases:—A feeder breaker comes out with a loud noise, bringing the machine breaker out also. On being replaced it comes out again for, say, six times. The outside department are notified, but before they have time to do anything it is again replaced and stays in, and nothing is found on examination to show what the fault was. In some cases the feeder has been kept off for half-an-hour while men were working along the line. Nothing has been found, and the circuit breaker has stayed in on being put back.

Three 500-h.p. engines were running on a traction load, when suddenly all three commenced to slow down. The machine ammeter and one feeder ammeter were hard over against the stops, yet neither circuit breaker came out. The catch of the feeder breaker had stuck, and would not move with a hard pull. If either machine breaker had been pulled out it would have probably damaged the engine, as the engines governed very badly, besides the delay in paralleling again; the feeder switch was therefore broken when the voltage had fallen to 300 volts. The circuit breaker was intended to have broken circuit at 600 amps., and it would not have broken at less than 2,000 amps. This is rather an exceptional case; after hammering the circuit breaker out when the voltage had fallen to 300 volts, and seeing that it was right with no current, it was tried on the short circuit again eight times in rapid succession, coming out each time. Three minutes were then expended in trying to speak to the depôt by telephone, without success; and another attempt was made to get the circuit breaker to remain in, and this time it did so. The cause, in this case, was a bad short circuit on a country route, which came off by itself as in other cases, but took longer about it. If the circuit breaker had not been replaced till the driver had walked to the nearest telephone, the service would have been off for half-an-hour at least. There were telephones on the feeder pillars, but they were out of order—the usual thing with telephones in feeder pillars in the writer's experience. The feeder circuit breaker was not got out, hammered out while the feeder circuit was alive, as it would have been too dangerous.

There are three principal types of circuit breakers in use in central stations—the I. T. E., the Thomson-Houston, and the Westinghouse. There are four conditions necessary for a successful circuit breaker:—

(1) It should break, no matter what way the load is put on.

(2) It should always break cleanly.

(3) It should allow of being replaced, in case of a short circuit, without danger to the operator, while the short is still on.

(4) It should allow of being held in contact easily, without danger to the operator.

All three of the above-named circuit breakers fulfil the conditions 1 and 2 fairly well, but they all stick occasionally, as apparatus of this kind has a tendency to do. In all three, also, the arc occasionally persists longer than it should, especially in the case of the I. T. E.

There is a danger of breaking the carbons of the Westinghouse circuit breaker after a

short, especially when the short is on ; and the operation of putting back is performed somewhat violently. The writer's view of this matter is, it would have been better to support the carbons all the way, and perhaps mount them on springs. In holding the circuit breaker in the Westinghouse there is a feeling of danger in case one should let the plunger slip, and it is impossible to keep clear of the apparatus, unless one assumes very awkward positions. The same remark applies to putting the feeder switch on in a short. The Westinghouse circuit breaker is also awkward to trip on a load.

"ASSISTANT."

II.—MECHANICAL ENGINEERING.

Emery Wheels and their Uses.—One of the most useful tools to be found now-a-days in an engineering shop is an emery wheel. In every large establishment, be it a machine shop, tool-maker's, foundry, ship or bridge-building yard, etc., we find these very necessary tools used extensively for all manner of grinding and sharpening purposes.

The prejudice that existed for a considerable period against the use of emery wheels appears now to have almost entirely vanished, and it is certainly surprising to notice how the manufacture and use of emery wheels has increased during the last 25 years. In fact, so universal have become their use that they are practically indispensable in any workshop wherever the nature of the work had previously been done by the aid of files and such like tools.

Among the principal uses to which emery wheels are put are those of fettling steel, iron, and brass castings, dressing steel and wrought-iron work, wheel tooth cleaning, card grinding, saw gulleting, grinding milling and other cutters (Fig. 1), hollow-ware work of all classes, such as stoves, pans, grates, etc., grinding and sharpening tools, spindle and flyer grinding, and for numerous other purposes. Not only are they used for external grinding, but a large number are required for *internal* grinding, such as grinding the inside of shell moulds, wagon bushes, axle-boxes, and articles of a similar description. Then in the Midland counties a quantity of emery mandrels, or rollers, are used by pin and needle manufacturers, the sizes of these generally ranging from 10 ins. to 14 ins. long, by 1½ ins. up to 4 ins. in diameter. Another style or shape is the "cup" (or "dish") wheel (Fig. 2) ; this class of wheel is for grinding on the face, and in many instances is used when running horizontally.

Emery wheels, of course, are made in various grades ; for instance, a wheel that is required for dressing castings is generally made very coarse, whereas in the case of grinding tools with water, and for fine grinding, it is necessary for the wheel to be made from much finer emery. Although many may be aware of the fact, yet it might be mentioned that the harder a wheel is made the slower it cuts. On the other hand, should a wheel be soft and open, then it cuts quickly, but soon wears "down" or "away."

The two principal kinds of emery from which the wheels are manufactured are the Turkish and the Naxos. The former stone (or rock) is found in the districts near Smyrna, in Asia Minor, while the Naxos—which is supposed by experts to be of a much superior quality—comes from the island of Naxos, in the Greek Archipelago. After being imported, the stone is crushed into smaller pieces by means of powerful breakers, or crushers, after which it is sized and sieved by special machinery, into sizes generally varying from 6 per inch up to 180 per inch. In the process of crushing and sizing there develops a large quantity of dust or flour, as it is called, and this is used largely by cycle-makers and electro-platers for polishing purposes.

The success of emery wheels depends to a great extent upon two points, viz., running them at the correct speed, and being properly balanced and mounted. With respect to the latter, many engineering firms within recent years have adopted what are called safety flanges or washer plates. The wheel itself is made fuller at the centre than at the edge, while the flanges are made to suit (Fig. 3).

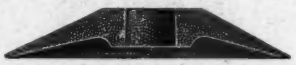


FIG. 1.—WHEEL FOR GRINDING MILLING CUTTERS

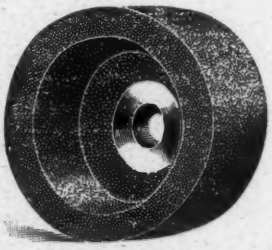


FIG. 2.—"CUP" (OR DISH) WHEEL.

FIG. 3.—EMERY WHEELS.

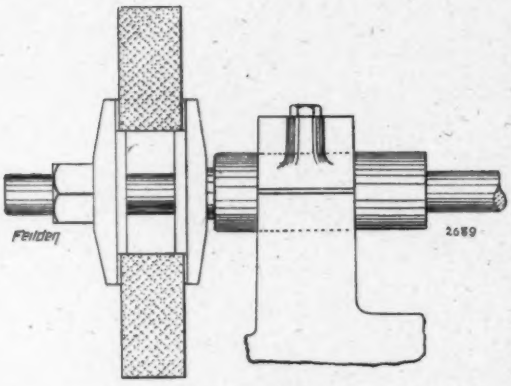


FIG. 4.—EMERY WHEELS.

The most general method, however, appears to be that of having the centre hole of the wheel made about one-third the diameter of the whole wheel (as Fig. 4); thus a 24-in. diameter would have an 8-in. hole; an 18-in. diameter with a 6-in. hole; a 12-in. diameter with a 4-in. hole,

FIG. 5.—BUFFING WHEEL.

and so on, the flanges generally being one-half the diameter of the wheel itself. In all cases rubber insertion washers should be placed between the wheel and the flanges. Many users have the emery wheel with the centre hole the size of the spindle, but it should be borne in mind that the wheel ought not to be wedged or driven tight on the spindle; it is advisable to have the hole in the wheel say $\frac{1}{16}$ in. larger.

With respect to the approximate speeds, these vary, of course, according to the diameter of the wheel. A 36-in. diameter will probably be found the most effective, when used for ordinary general purposes, running at about 550 revolutions per min.; a small diameter, say 6 ins., would, however, revolve at 2,500 revolutions per min. and be perfectly safe. When, however, the wheels are intended to be used for wet tool grinding, manufacturers generally estimate the most effective speed as about two-thirds that for ordinary grinding.

Emery wheels, of course, get out of truth by wear, and require looking to now and again; if necessary, they can be turned up by a diamond tool. Good black diamonds are, however, exceptionally high in price just at present—probably three times as expensive as they were a couple of years ago. For instance, the writer was recently inspecting a parcel of these diamonds, and the price quoted was £12 10s. per carat, whereas a similar class and quality of stone at the time mentioned could have been bought at 70s. to 80s. per carat. Not only are they expensive, but really good stones are difficult to get hold of, the demand from South Africa and Australia for mining purposes calling for a large quantity. A good substitute for the diamond tool is what is called a "dresser," consisting of a set of hardened steel cutters set in a special kind of holder.

When the wheels are sent out by the makers they are usually turned up true all over. Notwithstanding this, it has in some cases been noticed, when the wheel has been mounted on the flanges and fixed on the machine ready for use, that it is slightly out of balance. This is often due to the unequal density of the iron flanges. A good plan to ensure perfect balancing is to have a couple of trestles with iron or steel surfaces at the top, and by placing the spindle (on which the emery wheel is mounted on the flanges) upon these two surfaces, which by the way must be perfectly true, the one side that is slightly heavier than the other will naturally fall to the bottom. All that is then necessary is to mark the opposite side with a piece of chalk, and pour lead or white metal into the centre or spindle hole sufficient to restore the balance.

The machine carrying the wheel or wheels should be heavy and strong enough to withstand the strain brought upon it. There should be neither vibration nor spring, and it should be bolted to a solid foundation. The bearings of the machine should on no account be allowed to get hot, as sometimes this is indirectly the cause of an emery wheel breaking, for, as the bearing gets hot, so in turn does the flanges on which the wheel is mounted; this causes the wheel also to get warm and expand, while at the close of the day, or at meal times, contraction takes place, and this continual expansion and contraction results in the wheel cracking, and finally breaking.

Another frequent cause of a wheel breaking is owing to it having received an accidental blow. Thus, when the wheel is set in motion, sooner or later—according to the length or size of crack the blow has caused—it flies to pieces, very often with disastrous results. Again, running at far too high a speed has been the cause of many wheels breaking; while may be, as in more than one case known to the writer, the engine driving the emery wheel and other machinery has been found to have been fitted with imperfect governors. Consequently, as is well known by engineers, it would

in such cases be utterly impossible to control the speed of the machine on which the emery wheels revolve.

In conjunction with the use of emery wheels are what are termed "glazers," or buffs. It is well known that no emery wheel will polish, however fine it be made. It will grind fine, but the fact remains that the surface of the article is still slightly wavy. To effect a smooth finish, therefore, glazers are brought into requisition (Fig. 5). They are built circular, and consist of well-seasoned timber—pine being considered the best for the purpose—glued and pegged together, and the edge covered with thick walrus or sea-horse hide. It is then coated with the grade of emery considered the most suitable for the purpose it is intended to use it for. The glazers themselves are fitted with flanges, which are usually bored to suit the spindle of the emery wheel machine. In cases where glazers are frequently required, the plan adopted is to have the machine fitted with an emery wheel at one end for grinding, and a glazer at the other end of the spindle for finishing.

In addition to the walrus buffs mentioned, there are other articles used for finishing, such as felt bobs, calico mops, etc. The calico mops consist of layers of calico (circular), and these are generally fastened together at the centre and fitted with leather washers. When revolving at a high speed centrifugal force causes all the layers to bear together; then by applying polishing paste or crocus composition to the periphery, a very highly-finished surface is obtained, such as is required by jewellers, electro-platers, brass-finishers, and others.

In conclusion, it is only reasonable to assume that every business-like manufacturer would not consider the equipment of his workshop perfect, unless it was well supplied with the most modern machinery; and very few, if any, can show better results than have been achieved by first-class machines, fitted with up-to-date emery wheels.

SAML. CHAPMAN, A.M.I.Mech.E.

Cutting Worm-wheels.—The following arrangement provides a quick and accurate method of finishing small worm-wheels by "hobbing" out the teeth with an ordinary plug tap. Figs. 1 and 2 show the mounting of the wheel blank in a slotted bar, held in the slide-rest of the lathe, with the tap fixed in a chuck and supported at the opposite end by the centre of the loose headstock. A turned bolt through the centre, as shown, permits the blank to revolve with its periphery against that of the tap. The accurate sizing of the blanks is most important, in order to obtain the exact number of teeth, and the centre line must exactly coincide with the height of the lathe centre, as in Fig. 2. The feeding must be easy and regularly put on at each revolution of the blank, until the full depth of the tooth is attained.

A. HUTTON.

[To ensure a *correct* number of teeth and prevent overlapping, it would be necessary to first divide the blank on the milling machine.—ED.]

Box Cramps for Planer.—In planing parallel bars of square section, or rectangular slabs of metal, some difficulty is presented at times in firmly securing them on the machine table, so that the full amount of surface can be operated upon, and also to avoid all possibility of the tool coming in contact with the holding-down cramps. The box-cramp shown at Fig. 1 is intended to be bolted to the table of the machine, and the work to be operated upon is gripped by the screws *S*, which pass through the sides, whilst various packing pieces can be used when required to raise the work to a convenient height. A couple of castings, varying in depth and width, will be sufficient to accommodate most jobs, and for small machines a length of 18 ins. to 24 ins. will be found most convenient. The sides of the cramp should be well stiffened with brackets as shown, and the base, insides of the channel, and the outside and top edges should be machined, the trued edges being most helpful for setting purposes, and the slotted holes for adjustment. It is particularly useful where a number of similar pieces are to be dealt with, and a great saving of time is effected by adopting it.

J. GREEN.

An Improved Furnace Cover.—The general type of air-furnace cover consists of a circular or square cast-iron plate ribbed on the top side and with a central lug for lifting or sliding it into position. This form of cover, after some little time, becomes distorted and ceases to be of much service. The illustration shows the section of a composite form of cover, the cast-iron dome enclosing a fire-clay slab, kept in position by a wrought-iron ring held in recess by countersunk screws. The arrangement is applicable to furnace doors hung either in a vertical or horizontal position, and although the initial expense is a little more, they soon pay for themselves by the more efficient working, there being less absorption of heat and less liability to twist the cover, whilst the renewal of the fire-clay slab is only necessary after a couple of years' use. "BRASSEY."

[The mould for a circular dome is readily "struck up" in green sand with a couple of strickles, thus saving cost of pattern, also slabs of any size to order are easily obtainable.—ED.]

The Loam Moulders' Horse.—The horse or top spindle-bearing shown at Fig. 1 is a common feature in any foundry doing loam work. Its average height from the floor to the top is about sixteen feet and its distance from the wall eight feet, but variations are made to suit the different requirements. The horse, when in use, is kept in exact position—after the loam spindle has been set vertical with plumb-rule—by a tie rod, one end of which is fastened to the wall, leaving the other to drop into holes at set distances or one about mid-way of the arm. It is free to slide on the spindle, which, in turn, is supported by wall brackets as shown, and is usually locked in position by a set screw. The various methods

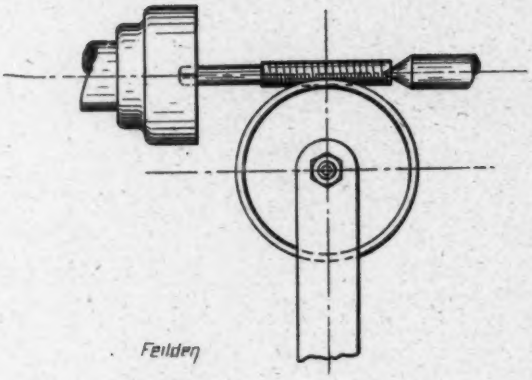


FIG. 1.
CUTTING WORM WHEELS.

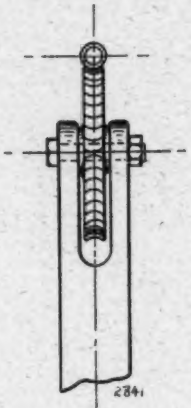
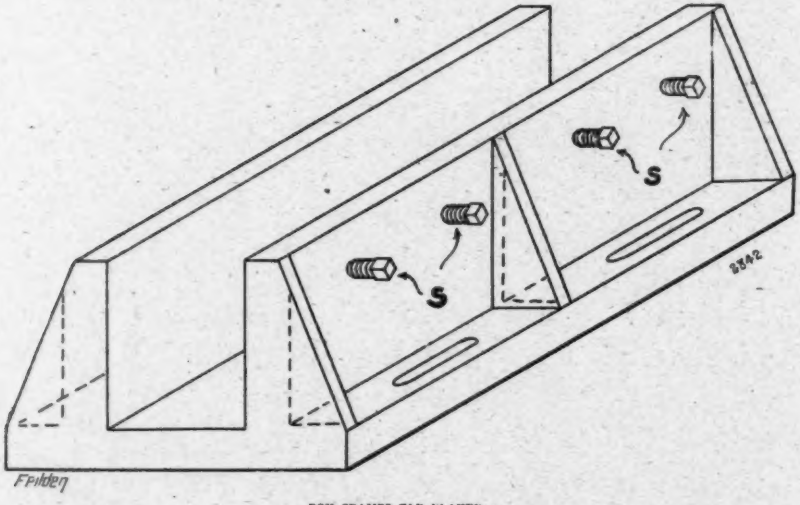


FIG. 2.



BOX CRAMPS FOR PLANER.

IMPROVED FURNACE COVER.

employed to secure the top of the main spindle are shown at Fig. 2, the most effective and least troublesome being the hinged end, No. 4. The illustration shows the cap pushed back for the admission of the spindle. The cap is kept closed by a catch fastened on the end of the arm, a light staff being kept handy to release it when it is necessary to remove the spindle. The arm or gudgeon on the main spindle is kept to the required height by a collar on the underside.

G. BUCHANAN.

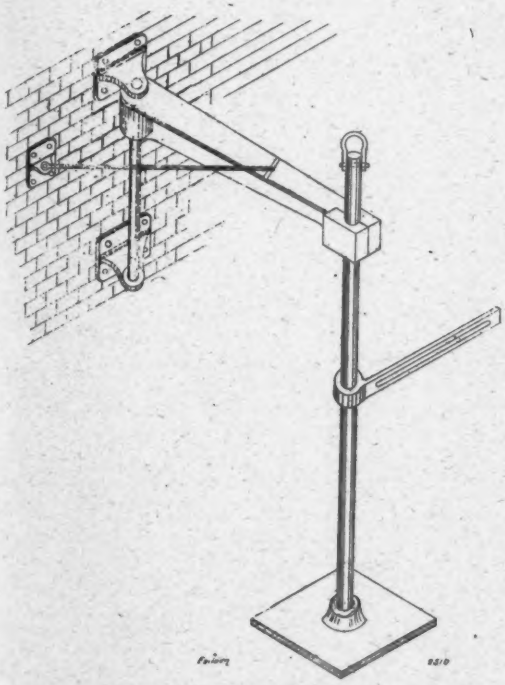


FIG. 1.—THE LOAM MOULDER'S HORSE.

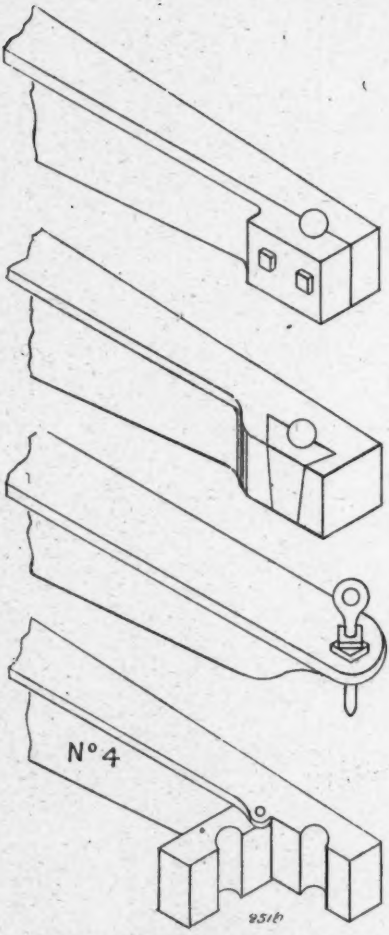


FIG. 2.—THE LOAM MOULDER'S HORSE.

The purport of this section of FEILDEN'S MAGAZINE is to give the skilled mechanic an opportunity of bringing his practical ideas and experience into print. Inventive capacity and careful thought on the part of the workman is what we desire to encourage and foster. To this end we invite practical suggestions, which, if accepted, will be suitably paid for. Wherever possible, drawings should accompany the contribution; rough sketches will suffice, as, when draughtsmanship is at fault, we will do all that is necessary to render them fit for publication. Nothing will be too poor for a careful inspection.

ONE GUINEA WILL BE PAID FOR WHAT, IN THE OPINION OF THE EDITOR, IS THE BEST CONTRIBUTION OF THE MONTH.

INDUSTRIAL PROGRESS

ENGINEERING NOTES AND COMMERCIAL INFORMATION

FROM ALL SOURCES.

A Mechanical Locomotive Stoker.—One of the most promising inventions in connection with locomotive practice is a mechanical stoker invented by Mr. John Kincaid, formerly an engineer of the Chesapeake and Ohio Railroad in the United States. This stoker, already dubbed the "iron fireman" by the railroad men, consists of a hopper of sheet metal, carrying two small screw conveyors which push the coal forward and in front of a ram or plunger lying in a trough. A small opening in the latter permits the dust and dirt accumulating behind the ram to escape. The conveyors are operated by a small engine under the front of the hopper, through the medium of a ratchet. The piston operating the ram lies inside a casting, and steam from the boiler is connected to a pipe in front of the casting. This operates the ram and the small engine, which merely runs the conveyor. The steam chest is situated where the valves controlling the stroke of ram are located. There are three such valves, to give three different impulses to the ram, which distributes the coal alternately over the front, middle, and back part of the grate; and they are controlled by three cams on one of the conveyor shafts. The regular fire-door is replaced by a special casting, and a curved plate in front of it is a deflector, distributing the coal across the width of the fire-box. A small door covering the upper portion of the fire-box permits inspection of the fire, and the use of a hook if necessary. This has an outside flange turned up at an angle so that it is lifted automatically by any lump of coal which is too large to go under it, giving an almost illimited range from slack to large lumps. The whole device is extremely simple, compact, and practical, and does great credit to its inventor. Our contemporary, *Railway and Locomotive Engineering* (New York), in its May issue, contains illustrations showing the construction of this stoker at a glance, and also a special article describing a day spent on a locomotive provided with it, which so plainly demonstrates its usefulness and practical working capacity that its general adoption in the near future appears to be an unavoidable conclusion.

Smokeless Firing.—Recent railway literature abounds with contributions on the theory of smokeless firing; but better than theory is a practical demonstration, and it may interest our readers that, according to a letter by an American engineer published in the June issue of *Railway and Locomotive Engineering*, the problem seems to be successfully solved on a Californian line. The author of the letter, Mr. James H. Hughes, of San José, writes as follows: "The majority of our runs are fast locals—1 hour and 55 mins. to cover 50 miles; make from 30 to 35 stops; load milk, unload milk cans; and, with plenty of express and baggage thrown in on the side to help us lose time, it is easy to see that neither the engine nor fire can be favoured very much. Our engines are equipped with a fire-brick arch, and we use Bates's baffler door. They have 18 × 24 and 20 × 24-in. cylinders, and we pull from four to six cars on the local runs, and from eight to twelve cars on the through runs. We make from 28 to 35 miles to the ton of coal on passenger, and from 20 to 25 miles to the ton of freight, and 45 cars are a train. About the only time our passenger trains make enough smoke to notice is in pulling out of a station when the fire is being forced. At other times a slight puff as the green coal strikes the fire is the only indication of smoke. The coal we burn is a poor quality of Carbon Hill (bituminous) screenings, and is very prolific as a smoke agent if heavily fired. I cannot speak for the swing-door, never having fired one, but the baffler door has proved a solution of the smoke problem here. It is a trap-door, 6 × 18ins., with a deflector plate to pass the air drawn through the door under the arch before it strikes the flues. It is fired open all the time, and the constant top draught, combined with light and careful firing, almost eradicates the smoke nuisance. I hardly believe it possible to use the one-shovelful method with bituminous screenings, where the engine is worked at 8 or 10 ins., and furnish the required amount of steam; but a man can avoid 'fogging' the country up, even though it is necessary to fire a bit heavier, if he uses good judgment."

Improved Accumulator Plates.—Among the various processes for making plates of porous lead for use in accumulators recently devised, attention is directed to a method patented in Germany by Richard Baur. The inventor, instead of treating the molten lead, as is the usual practice, by a jet of gas or vapour, introduces a substance, such as sulphur, for instance, which by contact with it is volatilised, and penetrates the mass during the

period of cooling. Sulphur has the property of combining with the lead to form sulphide, and the latter, when decomposed by dilute hydrochloric acid, leaves a mass of porous lead. In practice, the two halves of a plate mould are heated, and a small quantity of molten sulphur is introduced, which results in covering, after cooling, the sides of the mould with a layer of sulphur. The lead, heated to redness, is then poured into the mould, and the sulphur, being vaporised, penetrates the whole mass. When, after cooling, the plate is removed from the mould, it consists of lead, sulphide of lead, and an excess of sulphur. The latter is removed by washing the plate, which then is treated with dilute sulphuric acid, in order to decompose the sulphide, and finally consists of pure lead only in an extremely porous condition, being excellently adapted for use in accumulators.

A British Photographic Developer.—Photographers have been so accustomed to looking to the Continent for novelties in the way of photographic chemicals, that the appearance on the market of a distinct chemical compound, for developing the latent photographic image, manufactured in England by Messrs. Wm. Burton & Sons, of Bethnal Green, London, has naturally attracted a good deal of attention. Synthol, the new developer which claims this unique distinction of home production, is an entirely new chemical compound which had never seen the light of the laboratory or factory before its invention by Mr. Edgar S. Barralet, the chemist at Messrs. Burton's, who was educated at the East London Technical College, a testimony to the value of such institutions to the nation; enabling as they do, as in this case, the opening up of branches of manufacture which have hitherto remained in the hands of our Continental rivals. Synthol is a light drab crystalline powder. Unlike so many of the new drugs and chemicals we hear of, it is not derived from coal-tar but owes its origin to a certain class of plant. When dissolved in water in conjunction with the requisite quantity of sodium sulphite, synthol gives a developing solution of remarkable vigour, which quality it retains even after many plates have been treated in it. A 1 oz. bottle of the chemical will suffice for the successful treatment of over 1,000 plates of ordinary size—a proof that it may claim to be economical to use, a fact that ranks just as high in the mind of the practical photographer as its domestic origin. Taking it all round, synthol is every bit as good as any of its foreign rivals and in some respects it can claim advantages over individuals; thus, for example, it produces no injurious effect on the skin of the operator. It does not produce stains, and can be used in cases where pyrogallic acid cannot. It is to be hoped that the pioneers in this field will meet with the success that an effort to exploit British invention deserves. A trade cry of "made in England" should not avail, unless the article of manufacture can claim the virtues of high qualities and low price. In the case of this British developer these requirements are thoroughly fulfilled, and the fact of its origin should add an extra zest to its popularity.

Ernest Scott & Mountain, Ltd., Close Works, Newcastle-on-Tyne, have, we are informed, secured an important contract in South Wales, for the Port Talbot Steel & Iron Co., in connection with the new steel rolling mills which that firm are erecting. As this mill will be one of the most modern in this country, and probably the first new mill in which a complete equipment of electrically-driven machinery has been adopted, a short description of the plant may be of interest. The installation consists of a compound horizontal engine capable of developing 600 h.p., with a steam pressure of 160 lbs. per sq. in., driving on to a pair of Messrs. Scott & Mountain's generators, each generator being capable of giving an output of 200 kilo-watts, or collectively 400 kilo-watts, equal to 540 electrical h.p at the terminals. The current is utilised for working a 60-ton crane for the casting-pit, this crane being fitted with four electric motors, *i.e.*, one motor for heavy lifts, one motor for low lifts and for tilting the ladle, one motor for longitudinal traverse, and one motor for cross traverse. Over the casting pit a 10-ton crane of the three-motor electric type is being fitted, dealing with the ingots and bringing them to the rolling mills A 25-ton crane is placed in the rolling mill, and is utilised for changing the rolls, and also for taking the rolls to the roll turning and mechanics shop, which is placed at the end of the mill, so that the rolls can be lifted out of the housings and dropped straight into the roll turning lathes. A 5-ton crane is placed over the stock bank, which is also of the three-motor type and arranged for very quick speeds, so that the finished material can be handled and stocked very expeditiously. The live rollers in the rolling mills are controlled by independent motors, and also the screwing-down gear for adjusting the rolls. These motors will be operated from a platform by one man, who will have control of the cogging mill and also the finishing mill. The skidding gear is also driven by electric motors, so that, practically, the ingots, after being cast, are dealt with up to the time of their leaving the rolling mill, purely by electrical gear. The finished work, after it leaves the rolling mill, is taken by live rollers to the circular saws, which are also driven by electric motors, the cold saws and straightening machines being also driven in the same manner, and a further set of skidding gear, electrically driven, is also provided on the stock bank, so that the goods can be expeditiously loaded and stored. The works are also to be lighted throughout by arc and incandescent lamps, driven by a Scott & Mountain independent generator. Messrs. Scott & Mountain, who have for many years made a specialty of large electric pumping machinery, have recently completed many large installations, an important one for a Scottish company.

This plant consists of a horizontal compound condensing engine with a steam pressure of 80 lbs. per sq. in., driving on to a Scott & Mountain generator of 130 kilo-watts capacity. The pumps, which are of the firm's special three-throw mining type, with rams 11-in. diameter by 18-in. stroke, and deliver 500 gallons per minute against 600 ft. head, are driven by a 140 h.h.p. electric motor.

Opportunity for Shipbuilders and Marine Engineers.—In consequence of the recent law limiting the coasting trade in Russia to Russian vessels, a great demand is likely to arise in the near future for foreign-built steamers for river and coast service, and also for machinery and appliances for the local shipyards, which will undoubtedly be crowded with orders. The ukase covers the trade between European Russia and Asiatic Russia; but, owing to the heavy war demand in Asiatic Russia, that part of the territory is temporarily exempt from this decree. However, as soon as this demand ceases, it is certain that the exemption will be withdrawn and the coast-trade law strictly enforced. The Russian merchant marine has developed rapidly of late. A few years ago the merchant fleet consisted of a very few steamers and about 200 Finnish sailing ships, employed almost exclusively in the Baltic wood trade: to-day more than 3,050 steamships (including river steamers) are flying the Russian flag.

An Electric Railway between Vienna and Pressburg.—From information published in the *Oesterreichisches Handels-Journal*, the above line is to be constructed within the very near future, for the preliminary work is completed, and the representatives of the Government are at present arranging the final details, regarding the use of the bridge across the Danube and the work to be done at the Hungarian end of the line, with Messrs Siemens & Halske, who have obtained the contract, according to which the line is to be completed by March next year, and trains are to run at intervals of one hour.

Industrial Catalogues of Foreign Importers to Russia.—The advice repeated again and again by British and American consuls to their countrymen to send their catalogues and price lists to Russia not in English but in Russian, as the only means of attracting native buyers, induced a number of American exporting firms to have their catalogues and advertising matter translated into Russian and printed in New York. Their disappointment may easily be imagined when they were informed by their agents in the country of the Czar that all their labour has been in vain, since this carefully prepared printed matter was refused admission into the country because they had not complied with the Russian law governing the censorship of the Press, which requires that everything printed in the Russian language must receive the approval of the Central Committee of Foreign Censorship before it can be admitted or circulated in Russia. To spare to British importers an equal disappointment, it may be stated that all foreign exporters who desire to circulate advertising matter printed in the Russian language in Russia must address a petition to His Excellency the Chief of the Central Committee of Foreign Censorship, describing the character of the publication and its purpose, to which must be attached two copies of the publication for which admission is desired, praying for permission to admit and circulate the same in Russia. To this petition must be attached two Russian revenue stamps of the value of 1.60 rubles (84 cents), preferably two of 80 kopecks (42 cents) each. This petition will be more likely to receive immediate attention if written in the Russian or French language, though the same would be translated and forwarded if sent direct to the British Ambassador or Consul-General at St. Petersburg, if accompanied by the amount necessary to purchase the revenue stamps. Incendiary matter has been circulated in every form in Russia; hence the authorities censor everything that is printed as rigidly as they did a century ago.

Electric Progress in Ireland.—The Select Committee of the House of Lords, presided over by Lord Welby, has passed the preamble of the Shannon Water and Electric Power Bill. The object of this important measure, in consequence of its bearing on the industries of the West of Ireland, is to incorporate a company with a capital of £360,000 and £180,000 borrowing powers, and empower them to carry out a scheme to utilise the waters of the River Shannon for the purpose of generating electricity, and to supply energy for lighting and power purposes over an area of 30 miles radius from the power-station, to be situated four and a-half miles from Limerick. The works will include a short canal to carry the waters of the Shannon to the generating station to be erected at Cloonlara, where a fall of 40 ft. is obtained. At a point six miles below the intake the water will be returned to the Shannon. It is hoped that the manufacturers of the city of Limerick will become the best customers of the company. The latter have entered into an agreement to supply the tramway company of the city with energy in bulk. It is expected that the Corporation, who support the scheme, will also take the current necessary for the lighting of the city. The Bill, having already passed the House of Commons, will, no doubt, soon become law.

Sewage Disposal.—The Commissioners charged with the inquiry into the best methods for the treatment and disposal of sewage, of which Lord Iddesleigh is chairman, have issued an interim report. They have arrived at the conclusion that, practically, there is no kind of land which is entirely unfitted for the filtration of sewage, though in the case of stiff clay and peat lands, the power to purify sewage appears to depend on the depth of the top soil. They are convinced that it is quite practicable to produce by artificial processes effluents which could justly be classed as good, and could be discharged into a running stream without danger of creating a nuisance. In conclusion, the Commissioners state it to be their opinion that in view of the great gravity of the problem of protecting our rivers against pollution, the creation of a permanent commission, or of a new department of the Local Government Board, is highly desirable. Such an authority, they add, should have the supreme power of dealing with all matters relating to rivers and their purification, and should, whenever an appeal is made to them, have the right and duty

to take action where the local authorities have failed to do so.

New Docks at Gibraltar.—According to the *Journal of the Royal United Service Institution*, there are three new docks under construction at Gibraltar, of which the largest, divisible into two, will be 850 ft. long, the second 550 ft., and the third 450 ft.; with a width of 120 ft., and a depth of 35 ft. on the sill at low water in each case. A length of 100 yds of the parade ground by the south mole has been cut off, and by banking out the sea the necessary space for these docks has been secured. According to information obtained a few months ago, only about a quarter of the largest dock, where the parade ground formerly was, had been excavated so far, but the concrete backing for the masonry was already in its place. The excavation of the smallest dock, though commenced only about eight months ago, was already down to the lowest level, but it will take another five or six months before the dam cutting off the sea from the intended outer extremity of the docks is completed, after which the intermediate dock and the outer portion of the large dock will be taken in hand. A space of foreshore, about 500 yds. by 150 yds., on the outside of the docks, along the foot of the old water-line of the fortification wall, has been filled in, and on this strongly-built sheds for machine shops and repairing establishments have been commenced; while torpedo-boat slips, in continuation of this filled-in shore, extending to the ragged staff landing-place, are rapidly approaching completion.

An Improved Brake.—According to the *Journal de Bruxelles*, experiments are being made at present on the Belgian railways with a new brake for railway trains which, it is claimed, will reduce the running time of the train while coming to a stop more than one-third for trains running at a speed of 80 kilomètres (49·7 miles) per hour. This braking device, known as the Luyers system, consists mainly of a friction pulley fastened to the axle, on which the shoes act, and permits, it is stated, a quick stop to be made with remarkable smoothness. After a series of very satisfactory trials, made with a car running on the lines of the Ghent-Terneuzen Railway Company, the Belgian Minister of Railways authorised the placing of the new brake on ten 15-ton cars provided with Westinghouse brakes, in order to make a conclusive trial, which took place in the presence of engineering experts representing the principal railway companies of France, Germany, the Netherlands, and Spain. According to the paper above mentioned, the results obtained were favourable at all speeds. While with the tire brake hitherto in use a train at a speed of 81 kilomètres (50·3 miles) per hour may be stopped within 290 mètres (990 ft). in twenty-five seconds, with the Luyers brake it can be brought to a halt, under the same conditions of adhesion and pressure and in less than sixteen seconds, within 171 mètres (438 ft.).

The Largest British Locomotive.—The economy arising from the use of powerful locomotives, both for express working and for goods traffic, is as fully recognised in this country at present as in the United States, and none of the British railway companies has more carefully kept this point in view than the Caledonian Railway. Some years ago Mr. McIntosh, the locomotive superintendent of that company, gave expression to this conviction by designing the well-known "Dunalastair" express engines, while lately he introduced on the Caledonian very large bogie wagons built to carry 50 tons each. These gave such excellent results and so much reduced expenditure that the directors of the companies have given orders recently for the building of a considerable number of additional wagons of the same kind. For the purpose, moreover, of being able to work them in very long trains without the use of double headers, over the large stretches of 1 in 73, 1 in 75, 1 in 82, and similar grades, which are met with on the Caledonian main lines, Mr. McIntosh has recently placed on the track the first of a batch of locomotives, which considerably excel both in size and power any locomotive ever built hitherto in this country. They will be known as the "600" class, and run on eight wheels, all coupled, of 4 ft. 6 in. diameter. The cylinders are 21 in. in diameter, with a stroke of 26 in., while the boiler supplying them with steam has a heating surface of 2,500 sq. ft. The tender, which is comparatively small, runs on six wheels, having a capacity for 6 tons of coal and 3,525 gallons of water. The weight of locomotive and tender together is 102 tons. As a matter of comparison, it may be mentioned that the locomotives next largest to these in Great Britain are the six-coupled bogie Highland Railway express engines, which, however, have a heating surface of 2,064 sq. ft. only.

Joining the Baltic and the Adriatic by Water-ways.—The readers of this section of FEILDEN'S MAGAZINE will have noticed, from the frequent references to the subject, that Germany is rapidly completing an extensive system of canals, which, considering the fact that freight rates on canal boats are but a fraction of railway rates, must have a very great effect ultimately upon the transport conditions in that country. The significance of Germany's policy is still further increased by the project under consideration at present by the Hungarian Ministry of Commerce, which appears to be nothing less than to establish a direct water route between Fiume, the Hungarian port on the Adriatic, and Stettin, the well-known Prussian sea-port on the Baltic, by joining the Danube and the Oder rivers. The Oder, at the mouth of which Stettin is situated, rises in the Austrian province of Moravia, not very far from the Danube, to which a canal can be built without much difficulty through a connecting valley. From the Danube a canal, already completed, leads to the Save River running parallel to the Danube, and thence the route will be *viâ* the Kulpa River to Fiume. The realisation of this enterprise will certainly have considerable importance for both Hungary and Germany.

In this section is presented every month a concise précis of the contents of the leading organs of the technical press and of the proceedings of the learned societies throughout Great Britain, the Continent, and America, and also, in a summarised form, the subject matter of the more important articles appearing therein.

This systematic record should prove of the greatest value to those of our readers interested in one or more specific sections of technology, trade or economics, or to those who have insufficient leisure to peruse the large number of publications now appearing.

In most cases where publications are not readily procurable, with the exception of Transactions of the Learned Societies, copies of the articles can be supplied on application by remitting 7d. Should any of our readers desire further information we shall be happy to supply it.

ARCHITECTURE AND BUILDING.

1. Construction and Design.

Concrete Construction.—*An American Engineer on Concrete Construction.* This paper contains a number of useful suggestions based on the actual experience of the author, who strongly advocates the use of a wet mixture of such proportions as to give the maximum of strength under compression, always using Portland cement, and who advocates the introduction of large stones in the heart of the mass where economy is necessary, but is opposed to the cheapening of the concrete.—*British Architect*, July 12th, 1901, pp. 33-5.

Office Buildings.—*The New London Offices of the Mutual Life Insurance Company of New York.* The author, after pointing out that from an architectural point of view London owes an immense debt to Insurance Companies, gives a concise description of the premises above named, situated at 16, 17 and 18, Cornhill, the cost of which, including freehold, amounted to about a quarter of a million sterling.—*Stone Trades Journal*, July, 1901, pp. 10-13. (Ill.)

Village Churches.—*Little Waldingfield Church.* The author reminds us that when wandering afar in the Colonies or in the United States nothing clings so much in memory or stands out so conspicuously in the pictures of our native land as the village churches, rising from a picturesque cluster of tiled or thatched roofs. He then gives a short account of the small church of Little Waldingfield (400 inhabitants) situated among the pretty Suffolk lanes, four miles north-east of Sudbury.—*Builders' Journal*, July, 1901, p. 432. (Ill.)

2. Heating and Ventilation.

Heating.—*Volume of Water in Hot Water Heating Apparatus.* Comments on paper dealing with the above subject and read before the Society of Heating and Ventilating Engineers at this year's summer meeting in Chicago, by Mr. W. M. Mackay. The author expresses the opinion that the divergence of views expressed by manufacturers of heating apparatus on this point is due to absence of standard in this particular, but that in the manufacture of radiators, particularly for hot water use, a standard has been generally accepted, namely, that of providing one pint of water for every square foot of surface, which he considered to be well suited for all kinds of buildings, excepting, perhaps, all-glass structures. In support of this he describes some tests made by him for the purpose of ascertaining the correct data.—*Engineering Record*, July 13th, 1901, p. 39.

Superheated Steam for Heating.—*Tests of Radiators with Superheated Steam.* Extracts from a paper by Professor R. C. Carpenter, in which he states the interesting fact that in making a series of radiator tests during the spring of the present year superheated steam was inadvertently used in several cases, and, to his surprise, he found that the capacity for heat transmission by the radiator was thereby reduced. He adds that he had not yet had time to investigate the phenomena exhaustively, but gives the results of the various tests in his paper, and suggests that the cause of the fact that superheated steam is a poor medium for heating purposes is that it is much more like a perfect gas than saturated vapour, and therefore parts with its heat much less readily than saturated or wet steam.—*Engineering Record*, July 13th, pp. 39, 40.

Ventilation.—*A Suggestion in Ventilation.* This is a digest of a portion of a paper read at the recent annual congress of the Sanitary Inspectors' Association of Scotland, by Mr. James M. Rose, of Sutherland, entitled "Bionomical *v.* Artificial Ventilation." The author acknowledges that a few of the more recent ventilation systems are improvements, because of their ability to change the air in confined areas, but they were only within the reach of the wealthy. As a system suitable for the houses of people with moderate means he recommends making the room as air-tight as possible, which means, of course, the sacrificing of the fire-place and the substitution of a stove. As regards the introduction of the air, it might be made to enter by side slits about five or six feet above the floor. Then there would have to be fitted a main sewer or suction pipe below the floor, tapering off next to and let in below at the edge of the stove fire. At the opposite end there should be an elongated grating, tapering off into the suction pipe, to carry off the carbonic acid gas. Near the ceiling there would have to be several outlets, with branch pipes down behind the plaster to connect with the main suction pipe. The expended air would thus be forced upwards, and as the fire would draw from the easiest source a supply, it would extract all its requirements from these outlets, and all the exhalations from persons inhabiting the room would thus be destroyed.—*British Architect*, July 12th, 1901, p. 36.

3. Plumbing and Gasfitting.

Plumbing.—*Plumbing in the Prudential Buildings, Newark, N.J.* This is a description of the plumbing work done in four new twelve-storey buildings in Newark, New Jersey, U.S.A., containing the chief offices of the Prudential Insurance Company.—*Engineering Record*, July 6th, pp. 13, 14. (Ill.)

4. Miscellaneous.

Concrete.—*Armoured Concrete.* By Mr. Andrew Johnston, M.Inst.M.E. The author introduces his article by pointing out how little concrete is used in England, compared with other countries. In Australia Portland cement is largely used, but in Germany, Austria, and France a much more scientific application is made by the introduction of iron bars into the cement; and the author proceeds to describe the great advantages of this system, and to give practical examples of its use. (To be continued.)—*Stone Trades Journal*, July, 1901, p. 4.

Stone Drilling.—*When a Diamond Drilling Machine should be Used, and the Best and most Economical Method of Using it in Quarrying Hard Stones.* By Dr. Lungwitz. Translation of an interesting article on this subject published by the author in the *Berg- und-Hüttenmannische Zeitung.*—*Stone Trades Journal*, July, 1901, pp. 13-5.

CIVIL ENGINEERING.

1. Bridges.

Bridge Piers.—*Construction of the Cambridge Bridge Piers.* The article deals with the construction of the massive steel and masonry bridge that is intended to replace the old pile bridge known as the West Barton Bridge, and gives full details of the piers, which are being built on piles driven from 20 ft. to 40 ft. into a hard bottom, which consists of mud, sand, clay, and gravel, above a stratum of gravel from 30 ft. to 60 ft. below low tide. About 15,000 piles in all will be required for the ten piers, of which 7,400 have been driven so far.—*Engineering Record*, July 6th, 1901, pp. 8, 9.

Light Bridges.—*The Dunsback Ferry Bridge.* Description of a light highway bridge, 20 ft. wide in the clear and 206 ft. long, with three equal steel truss spans supported on two abutments and two steel cylinder piers, which was built about four miles above Echoes, N.Y., to replace the old ferry across the Mohawk River.—*Engineering Record*, July 20th, 1901, pp. 54, 55. (Ill.)

Suspension Bridges.—*An Interesting Old Suspension Bridge.* The above heading refers to the highway suspension bridge across the Guyan River, at Guyandotte, W. Va., which contains a number of quaint details that long since have become obsolete.—*Engineering Record*, July 13th, 1901, p. 31.

Viaducts.—*The Boone Viaduct.* Description of the viaduct that carries the new short line of the Chicago North Western Railway between Boone and Ogden across the Des Moines River. It is a double-track steel structure 2,685 ft. in length, having a maximum height of 185 ft., and weighing 196 tons.—*Engineering Record*, July 13th, 1901, pp. 29-31. (Ill.)

2. Canals, Rivers, and Harbours.

Dredging.—*The Great Dredges of New York Harbour.* Description of the great dredges being constructed by the Maryland Steel Company, according to contract, for the gigantic dredging work at the entrance of New York Harbour, which is in preparation and which will consist in digging a deep channel direct to the Narrows and, later on, several deep channels also along the Brooklyn shore. This will mean the removal and the transport to the deep sea of at least 16 million cube metres of mud, without interfering with the navigation.—*Revue Technique*, July 10th, 1901, pp. 298, 299. (Ill.)

Excavation.—*Hydraulic Excavation.* By Latham Anderson, member Engineers' Club of Cincinnati. The author of this paper, after a few remarks on the enormous changes effected upon the earth's surface by hydraulic mining, proceeds to discuss the various methods of hydraulic excavation, *i.e.* sluice or "ground" sluice process, the "giant" process and the "boom" process, and gives a description of a considerable number of practical cases of hydraulic excavation and hydraulic dam construction.—*Journal of the Association of Engineering Societies*, Jan., 1901, pp. 1-17. (Ill.)

Lighthouses.—*Modern Lighthouses.* Under this heading is given a short view of the gradual evolution of lighthouses up to the type at present prevailing. The author, Mr. G. Leugny, points out, with just pride, that in the manufacture of lighthouse apparatus France occupies the first rank; that it was France which gave birth to the lighthouse and developed its various improvements, and that even at present French firms construct lighthouse equipment for foreign nations.—*Revue Technique*, July 10th, 1901, pp. 302-4. (Ill.)

3. Miscellaneous.

Roads.—*Bicycle Paths in Portland, Oregon, U.S.A.* In the United States special tracks, in the streets and on the roads, reserved to bicyclists are coming more and more into favour. The first one, if we are not mistaken, was built in Pasadena, California; and the present article describes a number of tracks in the city of Portland, Oregon, which are under construction, under the supervision of the county Government. Great as the benefit of such tracks may be for cyclists, it is sure to be of greater benefit yet to the pedestrians. *Engineering Record*, July 20th, 1901, pp. 51, 52.

ELECTRICAL ENGINEERING.

1. Theory.

Dielectric Losses.—*Some Notes on Dielectric Losses.* By Charles Proteus Steinmetz. The author has incorporated in these notes the results of some determinations of the loss of power in electrostatic condensers on an alternative circuit, and at various frequencies and voltages. The condensers referred to consisted of tinfoil and paraffined paper, filled with paraffin by the application of heat and vacuum, so as to exclude the air as far as possible.—*Electrician*, July 5th, 1901, pp. 412, 413.

2. Electro-Chemistry and Metallurgy.

Deposition of Copper.—*Notes on the Deposition of Copper from various Electrolytes.* By A. A. Beadle. The author gives the results of a small series of experiments conducted with the object of ascertaining what difference of structure copper deposited from various electrolytes under varying conditions showed from that deposited by the sulphate.—*Electro-Chemist and Metallurgist and Metallurgical Review*, July, 1901, pp. 168, 169.

Electrolysis.—*Influence of Oscillations on Electrolysis.* By Arthur Morris. The author under the above title summarizes a memoir communicated to the French Academy of Science by Messrs. André Broca and Turchini, who state that they have discovered that a disruptive discharge with electrical waves of from 350 to 400 metres in length, *i.e.* with oscillations at the rate of about a million per second, have very different effects on an electrolyte in the circuit from those produced by an ordinary galvanic current.—*Electro-Chemist and Metallurgist and Metallurgical Review*, July, 1901, p. 166.

Galvanising.—*Electro-Galvanising.* The article consists of a description of a Cowper-Coles generative electro-galvanising plant which has recently been erected for the Vulcan Shipbuilding and Engineering Company at Stettin, to be used for the coating of boiler tubes for water-tube boilers and general shipyard work.—*Electro-Chemist and Metallurgist and Metallurgical Review*, July, 1901, p. 173.

Ozone Manufacture.—*Innovations in the Manufacture of Ozone.* Among the new features in the manufacture of ozone the author discusses a process worked by a Dutch manufacturing company known as the Namlooze Genootschap Industrieele Maatschappy Ozon; Elworthy's apparatus for the production of ozone; Strong's patented improvement in the method and apparatus for producing and collecting of ozone; Siemens' and Halske's process of purifying water by the combined action of ozone and iron; a process for the manufacture of permanganate by means of ozone; and other interesting discoveries in this field of electro-chemistry.—*Zeitschrift für Elektrochemie*, July 18th, 1901, pp. 788-92.

3. Measuring Instruments and Methods.

The Permeability of Iron.—*An Instrument for Measuring the Permeability of Iron and Steel.* By C. G. Lamb, M.A., B.Sc., and Miles Walker, B.A. This is a very interesting contribution, describing an instrument designed with the object of meeting the demand for a

simple, cheap, and reliable piece of apparatus for measuring the permeability of iron and steel. The authors constantly kept in view the important point that such an instrument should be simple to use, and that its calibration should be dependent on such principles as should render it incapable of alteration with time, and even with somewhat careless usage.—*Electrician*, June 7th, 1901, pp. 263-6. (Ill.)

Rheostats.—*Ward-Leonard Rheostats.* Description of a considerably improved type of rheostat, one of its noteworthy features being that in most of the older rheostats resistances are formed by the makers without any special regard to the question how they are going to be used in the new Ward-Leonard rheostat, three different types depending on—(1) whether the resistance has to carry steady currents; or (2) large momentary currents; or (3) large momentary currents, and afterwards smaller steady currents.—*Electrician*, June 14th, 1901, pp. 299, 300. (Ill.)

Testing Electrical Machinery. *Standard Specification for the Testing of Electrical Machinery.* Under this heading is given a slightly abridged translation of the standard conditions for the testing of electrical machinery proposed by a committee of the Verband Deutscher Elektrotechniker specially appointed to consider the problem.—*Electrician*, June 21st, 1901, pp. 339.

Test-Room Methods.—*On Test-Room Methods of Alternating-Current Measurements.* By Albert Campbell, B.A. The author describes a number of methods of measurement, some intended for special conditions, while others are generally applicable, and prefaces his remarks by the statement that many of the methods described are novel, while most of the others are not well known.—*Electrician*, June 7th, 1901, pp. 256, 257, and June 14th, pp. 297-9. (Ill.)

Theoretical Treatment of Power Measurement.—*Power Measurement in the case of Polyphase Circuits.* By Professor J. A. Fleming, D.Sc., F.R.S. The author, in this portion of a work written by him which will be published shortly by the proprietors of the *Electrician*, dwells on the measurement of the mean electric power in polyphase circuits, and analyses the theoretical treatment of the problem, which, as he points out, is somewhat complicated, owing to the phase relations of the various currents involved.—*Electrician*, July 5th, 1901, pp. 407-9. (Ill.)

4. Dynamos, Motors and Accessories.

Alternators.—*A High-frequency Alternator.* By Henry J. Chadwick. The author, after dealing somewhat generally with the position occupied by alternators in an electrical plant, proceeds to describe a high-frequency alternator in use in Tuft's College. It is of Mordey type and was designed and constructed by the electrical engineering students of the classes 1898-99, the design on the whole being due to Professor H. L. Hooper, but all the details were worked out by the students mentioned during their senior years.—*Western Electrician*, June 29th, 1901, pp. 440, 441.

Storage Batteries.—*The Storage Battery in Railway Service.* By Lamar Lyndon. The author deals with the use of storage batteries for equalising the load in the power-station, discusses the required size and explains, on the basis of definite examples, the operation of the battery and the problem of expenditure, and in conclusion describes the correct type of auxiliary machinery for the successful operation of the system.—*Street Railway Journal*, July, 1901, pp. 18-21.

—— *The Pascal Marine Accumulator.* By W. Hibbert. Description of a lead accumulator, the active materials of which are, as usual, péroxide and spongy lead. Its novelty consists in the position of the plates, which are arranged horisontally, and in the fact that the acid employed is phosphoric, not sulphuric. The advantages arising from this are said to be that a very large percentage of active material can be employed in connection with thin plates without risk of the falling away which would ensue were the plates arranged vertically; and an equal advantage claimed is the durability of the cell, due in part to its compact form, and in part to the use of phosphoric acid, by which the tendency to local action is greatly diminished.—*Electrical Review*, July 26th, 1901, pp. 131-3. (Ill).

Storage Batteries.—*The Influence of the Temperature of the Acid upon the Capacity of the Lead Accumulator.* By M. N. Schoop. Under the above title the author endeavours to give a theoretical explanation of the effect of warmth upon the diffusion of the acid in lead accumulators, to which as early as 1892 attention had been drawn in this country by Messrs. J. N. Gladstone and W. Hibbert.—*Zeitschrift für Elektrotechnik*, July 21st, 1901, pp. 353-6, and July 28th, pp. 360-64.

The Gould Storage Batteries at the Pan-American Exhibition. Description of an accumulator battery having a capacity of 2000 ampères for 8 hours and up to 10,800 for 74 hours.—*Street Railway Journal*, July, 1901, pp. 50-2.

Batteries.—*Storage Batteries in Electric Power-Stations, controlled by Reversible Boosters.* By J. S. Highfield. In this paper the author discusses what appear to him to be the most essential points in considering the designing of batteries for the work they are called upon to do in central stations, and describes subsidiary apparatus which may be found of use and convenience in operating batteries.—*Electrician*, June 14th, 1901, pp. 290-92; June 21st, pp. 336-38; July 5th, pp. 402-5. (To be continued.) Ill.

Small Motors.—*Submerged Motor for Electric Boats.* This heading refers to a short account of a small portable electric motor for propelling small boats, which is being manufactured at the Submerged Electric Motor Company of Menomonie, Wis., U.S.A. The motor and propeller are attached to the boats in the place of the rudder, and the boat is both propelled and steered by the combination without any vibration being felt, as the submerged motor is not in but outside the boat.—*Western Electrician*, July 13th, p. 27.

Switches.—*Some Notes on the Design of Motor-Starting Switches.* By P. W. Davies. The author points out that no other portion of an electric motor equipment comes in for so much criticism and abuse, on the part of the public in general and from non-manufacturing engineers in special, as does the average motor-starting switch; he then examines into the design of the usual type of starting-switch, with a view to finding out in what way, if at all, it can be simplified and improved, and then offers a number of suggestions which, in his opinion, would remove many of the existing defects.—*Electrical Engineer*, July 26th, 1901, pp. 127, 128. (Ill.)

5. Electric Transmission of Power.

Electrical Mining Plants.—*Electricity in Mountain Mines.* By T. W. Brady. The author of this paper, read at a recent meeting of the American Institute of Electrical Engineers, gives an outline of the equipment of a few plants and their working, and, without going deeply into technical details, discusses the features best fitted for special cases, dividing the general types of mining plants into three.—*Electricity* (New York), July 19th, 1901, pp. 21-3.

Power Distribution.—*Neptune Bank Power-Station at Newcastle-on-Tyne.* Under the above heading is given a description of the first power-station in the United Kingdom intended to distribute electrical energy, not for lighting or traction, but for manufacturing purposes. This pioneer establishment is the joint undertaking of the Walker and Wallsend Union Gas Company and the Newcastle-on-Tyne Electric Supply Company, being formally inaugurated by Lord Kelvin on July 18th of the present year. Although a lighting plant and a tramway line will later obtain current from this station, for the present it will enable the shipyards and other industries on Tyneside to dispense with steam plant.—*Tramway and Railway World*, July 11th, 1901, pp. 344-54. (Ill.)

6. Electric Lighting.

Improved Electric Light.—*The Rasch Electric Light.* Although there has been considerable progress in increasing the percentage of luminous energy derived from the total energy consumed for lighting purposes, we have so far still been immeasurably behind the ideal of 100. In the ordinary gas light, only about one per cent. of energy is changed into light, the ordinary electric incandescent lamp transforms five per cent. into luminosity, the Nernst incandescent lamp changes ten per cent. into light, and in the electric arc lamp as much as 30 per cent.

have become luminous energy. A very remarkable step in advance, however, appears to have been obtained by the invention of Herr. Rasch, described under the above heading in the paper mentioned below. By using the same refractory materials that are present in the filament of the Nernst lamp, and by replacing by them the carbon rods of the ordinary arc lamp, Herr Rasch has obtained a beautiful steady light, in which 75 per cent. of the electric energy applied is rendered luminous. The article here referred to gives the experiments which led the inventor to this result.—*Electrical Review*, July 26th, 1901, pp. 141-43.

Power and Lighting Plant.—Description of the very interesting plant provided for the requirements of the *Chicago Inter-Ocean*, one of the great newspapers of the United States, which not only supplies the current for the lighting of the premises but also for working the type-setting and printing machines.—*Western Electrician*, June 22nd, 1901, pp. 421, 422. (Ill.)

7. Telegraphy, Telephony, and Electric Signalling.

Multiplex Telegraphy.—*The Mercadier Multiplex Telegraph.* Under this heading a short account is given of a system devised by M. M. E. Mercadier, professor at the Superior School of the Post and Telegraph Department of France, and Directeur des Etudes at the Polytechnic School, which has been before the French electricians for some years. The chief advantage claimed for M. Mercadier's multiplex telegraph is the increased capacity given by it to the telegraph lines. It is stated that upon a single line, protected from the induction of neighbouring wires, a complete system of twelve transmitters will give a capacity of from six hundred messages per hour, and to this must be added, partly as a consequence, the reduction of expenditure where this system is used.—*Electrical Review*, July 19th, pp. 122-24, and July 26th, pp. 139, 140. (Ill.)

Telegraphy.—*The Importance in Telegraphy of apparently Little Things.* By Thomas D. Lockwood. A contribution full of practical hints regarding the efficient operation of the various instruments, and containing the explanation of many inconvenient incidents which less experienced operators would hardly know how to account for.—*Electrical Review*, July 6th, 1901, pp. 12-13.

Telegraphy.—*The Application of Storage Batteries to Railway Telegraph Service.* By W. E. Athearn. The author, after pointing out the importance of the continuity of the service for handling of trains, which almost precludes the trial of any new departures, describes the success obtained by him with gravity batteries, which he was able to try under various conditions, owing to his connection with the Western Union Telephone Company. —*Electrical Review* (New York), July 6th, 1901, p. 16.

Telephone Exchanges.—*The New Trunk Exchange. No. I. Berlin.* Under the above heading is given a translation of an article published in the *Elektrotechnische Zeitschrift*, by Herr Lindau, in which the above-named telephone exchange is described, and attention is drawn to several interesting novelties. This exchange has a capacity of 10,600 subscribers' lines and 1,600 local and sub-exchange junctions, and was fitted up at a cost of about £62,500.—*Electrical Review*, July 26th, 1901, pp. 163, 164.

—— *The Shanghai-China Exchange.* This contribution consists of a somewhat concise description of a full multiple switchboard, made by L. M. Ericson & Co., Stockholm, Sweden, installed at Shanghai, China, having a capacity of 5,000 subscribers.—*Electricity* (New York), July 12, 1901, p. 25. (Ill.)

Telephone Switchboards.—*The Modern Telephone Switchboard.* By Kempster B. Miller. Digest of a paper on the subject read by the author before the New York Electrical Society.—*Electricity*, June 28th, pp. 345-8; July 5th, pp. 369-71; July 12th, pp. 384, 385. (To be continued.)

8. Materials and Methods for Conducting Currents.

Aerial Transmission.—*Notes on the Construction and Protection of Aerial Transmission and Distribution Systems.* By K. B. Thornton. The author describes how to carry out the various operations required in constructing an overhead line, such as wiring, tying, jointing, &c., and the precautions necessary for the protection of the various parts of the system against injury, especially such as may arise from meteorological changes.—*Electrical Review* (*New York*), July 6th, 1901, pp. 14-5.

9. Electric Traction.

Electric Brakes.—*The Westinghouse Electric Brake and Car Heater.* The brake and heater here described are quite distinct, and the former may be installed and used independently of the latter, but the operation of the heater depends upon the use of the brake, the heat produced being derived from the energy that would otherwise be wasted. The brake is a magnetic track-brake, which receives its power from the motors in the cars acting as dynamos, and acts both on the track and on the wheel. The current which supplies the brake passes through the heating apparatus in the car, and thus serves for the brake as well as for heating. If the heating is not required a rheostat is introduced which absorbs the energy expended in the brake.—*Street Railway Journal*, July, 1901, pp. 52-4. (Ill.)

Electric Locomotives.—*A German Electric Locomotive.* Description of a somewhat remarkable locomotive constructed last year by the General Electric Company of Berlin, for service at the Lagerhof railway station, in accordance, as far as possible, with the Prussian State Railway standard. Its weight is 24 tons, and it is powerful enough to draw a train weighing 150 tons at a speed of 31 miles an hour on a level.—*Tramway and Railway World*, July 11th, 1901, p. 357.

Electric Railway Equipment.—*Kinks on the Sutro Railroad, San Francisco.* The article deals with some novel features in the construction of the above railroad, now the Sutter Street Railroad, in San Francisco. These novelties comprise a system of block signals, a device for stopping generator sparking, a method for repairing rotted poles, &c.—*Street Railway Journal*, July, 1901, p. 17. (Ill.)

Electric Railways.—*The Boston Electric Elevated Railway, I. and II.* Description of an electric traction system characterised by high-speed trains required to bring the four out-lying residential suburban districts in close contact with the central urban portion of Boston, so devised as to have these fast trains terminate in the suburban centres and to complete the system by feeder lines radiating from these centres to cover the requirements of local traffic. The article consists of two sections, and contains details of equipment, a short account of new branch lines, and a concise outline of the plant at the lower stations and of the method of working the trains.—*Electrical Review* (*New York*), June 29th, 1901, pp. 815-19, and July 6th, pp. 5-10. (Ill.)

—— *Electric Railway in the Valtellina* (*Italy*). The article deals with an interesting three-phase high-tension plant, which will come shortly into operation between Lecco and Chiavenna, with a branch-line from Colico to Sondrio.—*Génie Civil*, June 15th, 1901, pp. 101-6. (Ill.)

Electric Tramways.—*The Southend Tramways.* Description of the tramway plant opened July last at Southend, which was constructed from the design and under the supervision of the borough engineer, Mr. A. Fidler; while Mr. D. G. Adamson, M.I.E.E., has been responsible for the electrical equipment, both in the station and on the tramcars. The track so far laid down is a single line throughout, laid with 90-lb. girder rails, having a total length of 7¾ miles.—*Electrical Engineer*, July 26th, 1901, pp. 120-25. (Ill.)

Polyphase Currents.—*Polyphase Transmission on the St. Louis and Suburban Railway.* Description of the intended expansion of the system by acquiring two three-phase dynamos of 1,200 kilo-watts each and equipping transformer stations. The expenditure will amount to £540.—*Street Railway Journal*, 1901, pp. 11-14.

Tramways.—*Tramway Equipment of Dundee.* Description of a new line, having about fifty cars in use. The electric energy is as yet furnished by the electric lighting plant of the town, but it is the intention to build a special power-station to furnish about 1,100 kilo-watts. *Street Railway Journal*, July, 1901, pp. 14-6. (Ill.)

Street Railways.—*Street Railway Progress in St. Louis.* The company at present in charge of the street railways in the metropolis of Missouri is the out-growth of a recent consolidation of nearly all the St. Louis street railways, and their intention is to replace six smaller power stations by two large ones. They own the magnificent repairing shop, the equipment and management of which forms the main contents of this article.—*Street Railway Journal*, July, 1901, pp. 1-11. (Ill.)

Suspension Railways.—*Suspension Railways at Loschwitz, Saxony.* The article describes the latest railway of the Langen type, which is especially interesting as being the first mountain railway of its kind for the conveyance of passengers. It was opened for traffic on May 6th, during the present year, and runs from Loschwitz, a village on the banks of the Elbe, about five miles from Dresden, to the top of the Rochwitz heights. —*Electrical Review* (New York), July 13th, 1901, p. 39.

Electrical Heating.—*A Novel Electric Heater.* Description of electric heaters containing some original features, and patented by Mr. Gardner C. Hawkins, of Boston, Mass. These are devised with the object of having the heat thrown horizontally into the room, to be heated before it rises upward. In one type this is effected by a fan resembling the well-known buzz fan, but having the blades located between a pair of cones, separated from each other by heating coils which have electrical connection with the same source of power that drives the motor. In this way, when the fan is revolved, the air is drawn through the cone and comes in contact with the heater coil being driven horizontally into the apartment. —*Electrical Review* (New York), July 6th, 1901, p. 24.

Magnetic Lifting.—*Electro Magnets for Heavy Lifting.* By G. E. Walsh. The author points out that electro magnets are not yet used on cranes and conveyances in this country as extensively as they ought to be, but their steadily increasing use in shops and works shows that they are being appreciated. The Pennsylvania Steel Company has an electro magnet capable of lifting 10 tons, and it is employed to pick up the mass from the furnace to convey it to the presses or elsewhere. The author dwells on the advantages of their use, and upon the necessity of designing them for the special employment for which they are intended.—*Electrical Review* (New York), July 13th, pp. 53, 54.

Physiological Action of Electricity.—*The Electrical Resistance of the Human Body.* By W. L. Hooper. The author points out that the literature concerning the problem is very unsatisfactory. The only fact indisputably known seems to be that the better the contact and the more moist the skin, the lower the resistance. Mr. Hooper describes the results of a series of experiments undertaken by one of his pupils in Tuft's College, and from these it appears that any attempt to determine the amount of current that may flow through a person's body in contact with a high-pressure wire by measuring the resistance of that body with a Wheatstone bridge and one or two battery cells is utterly futile.

Spectra of Current Discharges.—*The Induced Alternating-Current Discharge studied with Reference to its Spectrum and especially the Ultra-Violet Spectrum.* B. A. W. Wright and E. S. Downs. Under the above heading is reprinted an article from the *American Journal of Science*, in which the authors describe a number of experiments in the physical laboratory of Yale University, made with the object of locating a very great number of lines contained in the photograph of the spectrum of the discharge of a current of the above nature.—*Electrical Review* (New York), July 13th, 1901, pp. 37-9.

MARINE ENGINEERING.

1. Freight and Passenger Vessels.

River Steamers.—*Stern-Wheel Steamer for the Amazons.* Description of a fast stern-wheel steamer, recently completed by Cochran & Co., Ltd., Annan, Scotland, for the Bolivian Government.—*Marine Engineering*, June, 1901, p. 226. (Ill.)

2. Small Craft and Pleasure Boats.

Launches.—*Oil-Driven Launches.* Description of an oil-driven launch, 35½ ft. long, carvel-built of teak, one of them sent out to Brazil by Messrs. Vosper & Co., Ltd., of Portsmouth, who make this kind of craft a specialty. The use of oil as fuel, as this can be purchased in any part of the world, is of course a convenience in many cases, and the lamp causes neither smoke nor smell, as there is no wick, the arrangement being similar to that of the Bunsen burner.—*Marine Engineer*, July, 1901, pp. 133-4. (Ill.)

3. Equipment and Machinery.

Transmitting Orders.—*Electric Transmitters and Receivers.* Description of a number of ingenious and useful instruments exhibited at the Glasgow Exhibition by Messrs. Barr & Stroud, of 250, Byres Road, Glasgow, and designed to transmit orders or indications from one station on board ship to another, as for instance, from the conning tower to the gun stations, from the helm to the bridge, etc.—*Marine Engineer*, July 1st, pp. 118-19. (Ill.)

MECHANICAL ENGINEERING.

1. Boilers, Furnaces and Fuel.

Boiler Accessories.—*A Huge Liquid Fuel Burner.* Description of a large oil burner of the Bunsen type, recently constructed by the Clarkson & Capel Steam Car Syndicate, of Deverell Street, Great Dover Street, London, S.E., for supplying heat for a 200-h.p. water-tube steam boiler on one of the fire floats on the River Thames.—*Engineer*, July 12th, 1901, p. 47. (Ill.)

2. Compressed Air.

Pneumatic Tools.—*Portable Pneumatic Tools.* Description of various types of pneumatic tools placed on the market by the International Pneumatic Tool Company, Ltd., of London and Chippenham, a firm that claims to make all their tools in England, and to be British.—*Marine Engineer*, July 1st, 1901, pp. 126-7. (Ill.)

3. Engines and Motors.

New Type of Motor.—*Liquid Expansion Motors.* Description of a type of motor which, if not based on a novel idea, is at all events a novelty among motors of commercial value, namely, a motor based on the expansion of liquids. That of water from freezing to boiling point is equal to 4.3 per cent., and by selecting temperatures more distant from each other a still greater expansion takes place. Dr. D. Zimmermann of Ludwigshafen, on the Rhine, has succeeded in constructing a motor driven by the power developed by this kind of expansion, described under the above heading.—*Scientific American*, July 27th, 1901, p. 58.

4. Power and Transmission.

Power Transmission.—*Power Transmission by Belts—I.* By Forrest R. Jones. The author introduces his contribution by pointing out that there are two radically different methods of making belt connections between a pair of shafts for the transmission of power by them; by one method the belt is run directly from a pulley on one shaft to its mating pulley on the other; by the other, idle pulleys are introduced to increase the angle of wrap of the belt about the pulleys. The author dwells upon the advantage of a large angle of wrap and high speed as compared with a small angle and low speed, discussing the losses at the bearings of a shaft, the effect of belt pull in a vertical drive and the effect with a horizontal belt; and supports his arguments by careful calculations. (To be concluded.)—*American Machinery*, July, 1901, pp. 347-50. (Ill.)

5. Machine Works and Foundry.

Machine Tool Shops.—*Shops of John Lang & Sons, Johnstone, Scotland.* Description of one of the best and most progressive machine-tool building establishments in Great Britain, located in Johnstone, near Glasgow. Messrs. Lang & Sons make a specialty of light work, especially small and medium lathes, etc., of which the article gives an account in connection with a general description of the premises.—*American Machinist*, July 20th, pp. 731-5. (Ill.)

6. Machine Tools.

Machine Tools.—*Smith & Coventry.* Among the exhibits at Glasgow shown by this firm a bevel-gear planing machine is said to attract special attention. Besides these there is mentioned a flat turret-lathe, a rapid key-way cutting machine, and a few other tools.—*Engineer*, June 28th, 1901 (Supplement), p. iv. (Ill.)

—— *Thomas Shanks & Co.* Description of the very striking exhibit of this firm at Glasgow, containing some of the largest tools in the Machinery Hall. Three of them are referred to in detail, *i.e.* a powerful self-contained vertical and horizontal planing machine, a slotting machine, and a radial drilling machine. A short account of several others is added.—*Engineer*, June 28th (Supplement), 1901, pp. iv-vi. (Ill.)

—— *John Holroyd & Co., Ltd.* The exhibit of this firm includes the Liebert screw-milling machine, of which the largest and smallest types are illustrated in this article. The latter is an entirely new machine, but the former is already in use in various places.—*Engineer*, June 28th (Supplement), pp. vi, vii. (Ill.)

—— *Hulse & Co.* The exhibit of this firm at Glasgow is not intended to be of a representative nature. It would have been practically impossible for them to display some of their largest machines, so they contented themselves with showing smaller types and their latest improvements, and, as the writer remarks, those that they do show are worth attention.—*Engineer*, June 28th (Supplement), p. vii. (Ill.)

—— *Mather & Platt.* Among the exhibits of this well-known firm described here, there is a magnetic portable drilling machine which contains a number of novel features, and of which a fairly full account is given.—*Engineer*, June 28th, 1901 (Supplement), p. xiii. (Ill.)

—— *Carron Company.* The writer describes several devices which could be seen fitted to two lathes in the Glasgow Exhibition, and which were designed with the object of overcoming the difficulty of turning screws with threads not a multiple of the threads of the leader.—*Engineer*, June 28th (Supplement), pp. xiii-xv. (Ill.)

—— *John Hetherington & Sons.* Most of the machine tools described under this heading contain nothing novel, excepting as regards a few minor points. There is, however, one entirely new machine, a powerful milling and drilling machine, of which details are given, and among the most interesting tools are two metal saws.—*Engineer*, June 28th (Supplement), pp. xii, xiii.

—— *Alfred Herbert, Ltd.* The writer points out that it would be impossible and unnecessary to describe in detail the numerous machines included in this exhibit, for most of them are generally known, since there is no company in this country that has devoted so much attention to the improvement of machinery as this Coventry firm. He confines himself, therefore, to a full description of one of the most striking tools shown in operation in the Glasgow Exhibition, namely, the No. 4 hexagon turret lathe.—*Engineer*, June 28th (Supplement), pp. ix-xii.

7. Refrigeration and Cold Storage.

Cold Storage Vans.—*Irish Railway Enterprise.* Description of a type of refrigerator van recently adopted by the Great Southern and Western Railway of Ireland, which conveys considerable quantities of perishable goods per annum.—*Ice and Cold Storage*, June, 1901, p. 164. (Ill.)

Refrigerating Problems.—*Tables and Diagrams showing the Relative Efficiency of Power required and Refrigerating Effect of NH_3, SO_2, and CO_2.* By N. Munster. This tabulated information regarding the use of anhydrous ammonia, sulphurous dioxide and carbonic acids for refrigerating purposes is taken from *Die Zeitschrift für die gesammte Kälteindustrie*; and among other interesting facts clearly demonstrates the advantage gained, either in saving of power or increase of refrigerating capacity, by cooling the liquid after it leaves the condenser, more especially when CO_2 is used.—*Ice and Cold Storage*, June, 1901, pp. 149-52.

MUNICIPAL ENGINEERING.

1. Street Lighting.

Street Lamps.—Description of a lamp designed by Herr Schmitt, a German gas expert, and submitted by him to the Mid-Rhine Gas Association. He pointed out that Pirmasenz (Bavaria), where he lived, was a very windy town owing to its lofty situation, and none of the ordinary wind-proof lamps could be used, while the lamp constructed from his design had been in use for several years and gave complete satisfaction. Its chief characteristic is the absence of the slits at the top and the admission of air through holes at the base.—*Gas World*, June 29th, 1901, p. 1037.

Street Lighting.—*Kitson Incandescent Lighting.* Under this heading an account is given of the Kitson system of oil-lighting, an installation of which consists of a reservoir containing the oil, a lamp, and tubing to conduct the oil from the tank to the lamp. In the lamp the oil is vaporised by its own heat and converted into an oil-gas which then produces a brilliant incandescent light when burned within a mantle of refractory material. The cost of lighting by the Kitson system is the price of five-eighths of a pint per hour per 1,000 candle-power, so that the price of one gallon of standard oil is sufficient to defray the cost of 1,000 candle-power for twelve hours, or of 12,000 cand'e-power per one hour.—*Surveyor*, June 21st, p. 1752. (Ill.)

—— *The Simplification of High Power Incandescent Gas Lighting.*—Under this heading is given the description of a lamp to be known as the Welsbach-Kern Automatic Intensifying Lamp, which represents a great step in advance, not so much as regards efficiency—for the light produced is from 27 to 28 candle-power per cubic foot of gas, *i.e.* about 280 candle-power per 10 cubic feet per hour—but as regards simplicity, for no increased gas pressure is required, as has hitherto been the case in incandescent gas lamps, the ordinary pressure of 2 inches being sufficient. This improvement is due to Messrs. Brett & Henneberger, the engineers of the Company, but the latter own the patent.—*Journal of Gas Lighting*, June 4th, pp. 1503-4. (Ill.)

—— *Observations on Gases Burned in Slit and Welsbach Burners.*—By Dr. H. Bunte (Abstract). The author discusses the question how far the chemical constitution of a gas affects its usefulness with a Welsbach mantle, and after tabulating a number of experimental results, discusses their meaning. To this is added an abstract of a communication by Dr. Saintleben, of Bremen, published in the *Journal für Gas Beleuchtung*, containing some data concerning the effect of hydrocarbons on the illuminating power of gas used with Welsbach mantles, which, as he says, are in disaccord with those obtained in the laboratories of the German Continental Gas Association.—*Gas World*, May 11th, 1901, pp. 744-45.

2. Gas and Gas Manufacture.

Air-Gas Light.—*The Fischer Light.*—Description of one of the latest additions to the list of air-gas patents. The inventor, an Austrian, appears to have been quite successful, to judge from the reports coming from Vienna. Mr. Fischer's air-gas is said to be suitable for power as well as for light and heating, and to possess twice the calorific efficiency of coal gas, but it will be preferably used in places where no coal can be obtained.—*Journal of Gas Lighting*, June 18th, pp. 1672-3.

Gas Engineering.—*Some Differences between British and Continental Gas Engineering.*—By C. E. Brackenbury. A paper read before the Meeting of the Institution of Gas Engineers, from which it appears that in most points the Continental methods are ahead of our own, especially as regards the combination of beauty and utility. To this is added the discussion following the reading of the paper.—*Gas World*, May 4th, 1901, pp. 691-98.

Gasholders.—*The Large Gasholder for Newcastle.* The author of this contribution points out that the construction of a gasholder and tank is not an every-day occurrence, and sufficient time has elapsed since the building of the last plant and the one referred to in the heading, to render the new enterprise in some sense

an experimental undertaking, since the progress made in various technical branches demands that the latest developments should be embodied, and a comparison between the design submitted by Mr. W. Doig Gibb, at the request of the Newcastle Company, shows many interesting differences both in general as well as minor characteristics.—*Journal of Gas Lighting*, July 2nd, 1901, pp. 25, 26; July 9th, pp. 87, 88. (To be continued.)

Glasgow Exhibition.—*The Glasgow Exhibition.* A concise survey of the exhibits referring to gas manufacture and gas engineering, including the Exhibition lights, the section of domestic and other gas appliances and miscellaneous exhibits, as well as the features of the Machinery Hall.—*Journal of Gas Lighting*, April 30th, 1901, pp. 1118-20.

—— *Gas at the Glasgow Exhibition.* A short account of the exhibits that were in place on the opening day, including a Welsbach "Shadowless" Lantern, a Scott Snell lamp, a Keith compressor, the Kitson lamp, etc., and some exhibits in the department of motive power, and in the cooking and heating section.—*Gas World*, April 27th, 1901, pp. 627-30. (Ill.)

Water-Gas.—*Notes on Water-Gas Manufacture.* By Thomas Holgate. The author discusses the Dellwick and the Strache systems, and gives the result of his experiments instituted for the purpose of comparing water-gas manufacture under diverse conditions, hoping, as he says, that his data may be useful, since, although the manufacture of water-gas is undoubtedly very simple in some aspects, there reigns great uncertainty as yet regarding others.—*Gas World*, May 4th, 1901, pp. 674-80. (Ill.)

—— *Some Notes on the Conditions which prevail within a Carburetted Water-Gas Plant.* By W. J. Atkinson Butterfield. The author, after discussing the various systems, compares the Dellwick and the Lowe plant, *i.e.* generator, carburetter and superheater, as regards efficiency, in so far as they may be considered merely as apparatus for utilising the heat of the fuel consumed during the blows, describes experiments made by himself and their results, and submits various suggestions with regard to the working of water-gas plant.—*Gas World*, May 4th, 1901, pp. 698-701.

3. Sewerage.

Sewage.—*The Sewage Precipitation Works at Providence.*—Description of a sewage plant at Providence, Rhode Island, U.S.A., comprising 20 concrete tanks, 5 sludge reservoirs, press house, chemical building and laboratory, serving for the chemical treatment of the town sewage before it is discharged into the river.—*Engineering Record*, May 4th, 1901, pp. 416, 417. (Ill.)

4. Water Supply.

Filters.—*Bacillus* versus *Filter.* Under this heading the editor of the paper below-mentioned comments on the results obtained by Professor Harrocks in the Hygiene Laboratory of the Army Medical School at Netley, while experimenting with typhoid bacilli and Berkefeld filters of various sizes. In these experiments he found that thorough cleansing of the filter, accompanied by sterilising, failed to remove the germs from the filter, and sterile water passed through it became infected, while in every case in which a Pasteur filter was used, no bacilli were found after cleansing the filter, nor were there even any germs in the filtrate. This is a serious state of affairs, since the War Office has so largely adopted the Berkefeld filter, and the editor expresses the hope that the War Office will have a satisfactory answer.—*Public Health Engineer*, July 6th, 1901, pp. 1, 2.

Water-Conduits.—*The Torresdale Conduit at Philadelphia.* The aqueduct here described is 10½ ft. wide and 13 ft. and 15 ft. long, designed to furnish 300,000,000 gallons a day.—*Engineering Record*, May 18th, pp. 470-77. (Ill.)

—— *The Weston Aqueduct of the Metropolitan Waterworks, Boston.* By Alfred D. Flinn. Description of an aqueduct 13½ miles long, with a capacity of 300,000,000 gallons per day, containing some noteworthy feats in its construction.—*Engineering Record*, May 4th, 1901, pp. 418-20. (Ill.)

Submerged Pipes.—*Submerged Pipe Crossings of the Metropolitan Water Board.* By Caleb Miles Saville. The author describes various methods of laying water-pipes under and across rivers, to which Mr. Clemence Herschell and Mr. F. A. McInnes add the description of others of equal interest.—*Journal of the Association of Engineering Societies* (U.S.A.), March, 1901, pp. 193-222.

5. Miscellaneous.

Sanitation.—*The Principles of Municipal Sanitation.* By Dr. Paul Degener, Instructor at the Technical High School of Brunswick. The author analyses the various kind of refuse material collecting in modern towns, and discusses the method of removal and the most economic utilisation of waste products.—*Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereins*, May 10th, 1901, pp. 340-45 and May 24th, pp. 384-9.

RAILWAY WORK.

1. Motive Power and Equipment.

Air-Brakes.—*The Maintenance of Air-Brakes on Freight Cars.* By G. W. Rhodes, Assistant General Superintendent, Burlington and Missouri River Railroad. The author points out that the railways in the United States have, to an enormous extent, been equipping their freight-cars, within the last few years, with power-brakes, and that the question of maintaining these brakes in good condition is one of the utmost importance. In connection with this problem he endeavours to give an answer to the two questions, first, What methods should obtain to ensure the cleaning of triples at least once in every twelve months? and, second, Should there be few or many cleaning stations on a railroad or system of railroads?—*American Engineer and Railroad Journal*, June, pp. 171-2.

Brakes.—*Brake Leverage.* Under this heading the journal below mentioned publishes the first of a series of articles intended to teach the principles of brake-leverage or the handy practical problems, in the simplest manner possible, to all anxious to obtain information on the subject, proceeding step by step from the simple to the complicated, and using in explanation only simple arithmetic, so that all those who lack special mathematical knowledge may be able to understand the solution. This first contribution comprises the principles of "see-saw," force and direction, clockwise and counter-clockwise, equilibrium, and momentum.—*Locomotive Engineering*, May, 1901, pp. 213-15. (Ill.)

—— *Brake Leverage.* (Continued.)—This, the second instalment, contains the following sections: Stopping the Grindstone, Another Grindstone Example. Still another Grindstone Example, Wheel and Brake Shoe, and Stopping the Car Wheel.—*Locomotive Engineering*, June, 1901, pp. 259-60. (Ill.)

Engines.—*Feeding Railway Engines on the Road.* The author points out that only recently French railway companies have begun to make experiments in feeding engines without stopping the train, while this method, invented by the English engineer Ramsbottom, has been in use in other countries for many years. He then proceeds to describe the various systems employed in Great Britain and the United States, and the projects for introducing similar systems into France, where, so far, there exists only one plant for this purpose, namely, that completed last July on the Paris-Royan line of the State railways.—*Génie Civil*, June 8th, 1901, pp. 90-94. (Ill.)

Locomotives.—*Best Type of Engine for Heavy Fast Passenger Service.* By F. F. Gaines, Mechanical Engineer, Lehigh Valley Railroad. The author points out that the best type as regards wheel-base arrangement for any given road or run depends upon the conditions under which it is to be operated. The length and weight of train, the speed, grade, and curvature, are, as he says, all-important factors, and duration of grade, as well as the rise, has its influence. He suggests that it would be most economical, when track, maintenance of power, etc., are all considered, to select an engine that will do the work properly on the level, using a help for the grade.—*American Engineer and Railroad Journal*, June, pp. 195-6.

REVIEWS.

Standard Polyphase Apparatus and Systems. By Maurice A. Oudin, M.S., M.Am.Inst.E.E. 249 pages. 1900. Sampson Low, Marston & Co.

The author states in his preface that "These notes are intended for electrical engineers, central station men, and others who talk about, operate, or are interested in polyphase machinery."

This sentence describes the book far more accurately than the title. It has apparently grown out of the notebook of a man who is evidently practically familiar with many types of polyphase machinery, and engineers familiar with the subject will hardly read it through without finding useful hints on some points or other of American practice. It will be still more useful to readers who desire to obtain a superficial knowledge of the subject, with the object of talking learnedly to the untechnical, but the earnest student who takes it up in the hope of obtaining connected systematic knowledge of polyphase work will be doomed to disappointment.

The introductory chapter on alternating current terms is not required for the engineer familiar with alternate currents, and will hardly be intelligible to beginners. The error of stating the inductive E.M.F. to be expressed by $2NLI$, instead of $2N\pi LI$, will be confusing to the latter. Such errors as "lightning" for "lighting," which occurs more than once, and other misprints, are of minor importance.

The following are typical instances of the author's explanatory powers.

On page 86 we find: "Condensers are used to improve the power factor of circuits supplying current to motors by making the motors take current in proportion to the loads. The motors themselves are not improved, but the wattless current is offset by the leading current supplied by the condensers, and its pernicious influence confined to the local circuit between the condenser and the motor."

On page 94, in the chapter on Synchronous Motors, the following occurs: "It is necessary to use some extraneous source of power to start single-phase motors, and bring them up to speed. This is usually effected by an alternating-current motor. In some cases, where a direct-current source of power is available, the exciter may be used as a starting motor."

The concluding chapter is devoted to the consideration of the calculation of power transmission lines. A table of line constants, published by the General Electric Company of America, is given, with examples of its use. The table is apparently calculated for wires strung at a distance of eighteen inches apart, but no indication of this is given. The author does not, in fact, even mention that the distance between the wires is a factor to be considered.

These faults will not be of very much consequence to the engineer who is versed in the groundwork of alternating-current theory, and who consults the work as the notebook of a practical worker from which practical hints on special points are to be obtained.

We have, however, noticed them in some detail, because there is sufficient good material in the volume to make it of value to a much wider circle of readers than is the case at present. It appears to us that this object would be most simply attained by its revision by some one familiar with the elementary theory of the subject, and capable of expressing it in a form intelligible to the beginner.

Polyphase Electric Currents and Alternate Current Motors. By Professor S. P. Thompson, D.Sc, B.A., F.R.S. Second and Enlarged Edition, viii and 508 pages, 8vo. Price 21*s.* E. and F. N. Spon.

The first edition of this work appeared about four years ago, and was indispensable to every student of polyphase electric current work. During this interval the subject has developed from infancy to adolescence, and in order that Professor Thompson's work should retain its position as the standard work thereon, it became necessary not only to make extensive additions, but practically to recast it, so that to all intents and purposes it must be considered, in all but its name, as a new work rather than a mere new edition.

The first thing to attract attention is the sumptuous character of the paper and the excellence of the printing and the illustrations. Specially noteworthy among these are the coloured diagrams with a separate colour to each circuit, which are so happily employed to make plain the complexities of design inherent in polyphase electric generators. Another point worthy of special mention is the copiousness of the bibliographic references, and their insertion in the text, instead of being collected at the end of the volume as in the earlier edition, is a very great improvement.

The author assumes that his readers are already acquainted with the general principles of electric currents both continuous and alternating, and with the principal features of alternate-current generators. In spite of this, however, he devotes his first chapter to a recapitulation of some of the main points concerning alternate currents in general. It is not only the weakling who will thank him for this, for the clear though greatly condensed outline of general principles is supplemented by copious references both to treatises and to original papers, some of which are by no means generally known, so that this chapter, which the well-informed reader might otherwise be disposed to slip, will be highly valuable as a bibliographic guide.

The next chapter is devoted to the consideration of the elementary principles of polyphase current generation, and it is pointed out that as far back as 1877 Gramme had grasped the fact that the idle spaces between the coils of a monophase alternator might be advantageously filled up with coils feeding separate circuits.

Gramme was aware that it would not do to join all these coils together to form a single circuit, so he employed them to feed four distinct Jablochkoff

candle circuits. There is no evidence, however, that he ever attempted to combine the currents of different phases, or that he was aware that such a combination could be of use.

The principles of these combinations are clearly and systematically set forth in Chapter III., which also deals with the very important question of the economy of copper in polyphase systems of power transmission.

The next two chapters are devoted to the theory and practice of the design of two-phase and three-phase generators, with more or less detailed descriptions of numerous typical examples of machines constructed by the leading manufacturers, which are mainly Swiss, German, Austrian, and American firms. We are surprised at not finding an account of some of Ganz & Co.'s recent machines in this chapter. The next four chapters, dealing with the structure of polyphase motors generally and with the graphical and analytical treatment of the theory, are remarkably good and complete, and are supplemented by most exhaustive bibliographical references.

Chapter X. deals briefly with some examples of modern polyphase motors. This chapter, like the one dealing with examples of generators, is somewhat meagre both in the text and in bibliographical references in comparison with the fulness of treatment of the theoretical portions, and must be considered as providing practical illustrations of the theory so well-developed by the author than as anything like an exhaustive guide to modern practice in construction.

The next two chapters on hints for design and on the mechanical performance of polyphase motors are thoroughly good and well worthy of careful study. Chapter XIII., on single-phase motors, is somewhat of a digression from the plan of the work, but a useful one, as the information on the theory of their construction and action is not easily accessible elsewhere.

Chapter XIV., on polyphase transformers, contains a good deal of interesting information of a somewhat general character. The chapter only contains a passing reference to the important question of the frequency limits of rotary converters, and we hope to find in the next edition a more adequate consideration of the principles of their design, with further examples of the best recent practice.

Chapter XV., on the measurement of polyphase power, is very brief, but contains what it is essential for the reader to know with reference to more complete sources of information.

The two following chapters are rather disappointing. Chapter XVI., on the polyphase equipment of factories, after enumerating the chief advantages of an electrical system of power distribution, gives some brief particulars of several installations of the kind, references to full descriptions being given in one or two cases, and these references form the most valuable part of the chapter.

Chapter XVII., on the distribution of polyphase currents, does not deal as might be expected with the problems of polyphase current distribution, but does little more than enumerate instances. If references were given which would enable the reader to find detailed descriptions of the plants enumerated the chapter would be a valuable one.

Chapter XVIII., on polyphase electric railways, is necessarily brief, as there was very little information available on this subject at the time the chapter was written.

The work concludes with two excellent chapters on the properties of rotating magnetic fields and on the early development of the polyphase motor. In an appendix the author puts forward a new notation for arithmetical operations with complex quantities, which he thinks makes the subject easier for the beginner.

Professor Thompson is such an excellent teacher that we have no doubt he has found it to be of assistance to his own students, and far be it from us to say a word against anything which can smooth the path of the learner. It must, however, be borne in mind that there is not much use in smoothing the path for weaklings who will never be anything more than beginners, and that if they want to learn what others have done in the graphic treatment of alternate current problems, they will have to learn to follow the accepted notation, which seems to us possibly however only from long familiarity, more natural and simpler to work with than the substitute suggested by Professor Thompson. Even if the use of Thompson's notation should make the first step easier, it may keep the learner from reading what he would otherwise profit by on account of having to render himself familiar with the accepted notation.

Practical Electrical Testing in Physics and Electrical Engineering. — By G. D. Aspinall Parr, Assoc. M.I.E.E., head of Electrical Engineering Department, Yorkshire College, Victoria University. London, New York, and Bombay: Longmans, Green & Co., 1901. 392 pages. 231 illustrations. 8*s.* 6*d.*

The aim of this book is to provide a systematic course of instruction in electrical testing connected with physics and electrical engineering. The author recommends this course as suitable for the first and second year's work in the laboratory before proceeding to advanced electrical engineering work. In our opinion the author is too hopeful in expecting students to perform all the experiments described in a two-years' course, for he has not rested content with a description of the best method of performing any experiment, but has given a large number of alternative methods — even as many as four alternatives in some cases. This, no doubt, is an excellent plan from the teacher's point of view, for, with such alternative methods before him, he can choose for any student that particular method for which the necessary apparatus is at the moment available. We therefore do not hesitate to say that this book would be found very useful by demonstrators who have to arrange experiments for their students; but we believe that if the book were to be put into the hands of the students themselves, it would be apt to lead to confusion. It must be remembered that the students for whom the book is intended are *beginning* a course in practical physics, and are there-

fore making their first acquaintance with measuring instruments. It is only at a later period that they can be expected to know why one instrument, or set of apparatus, should be preferred to another, and it is the function of the demonstrator to teach this. No book can relieve the teacher of his functions.

It is impossible in our limited space for us to attempt to describe the experiments which the author has chosen, but the course is an excellent one, and we can cordially recommend it to teachers in laboratories. In each experiment an explanatory introduction is given; then the apparatus required is described, and then comes a list of the observations which must be made. Magnetic experiments come first in the book, then measurements of electrical properties, ending with self and mutual inductions. Nothing of importance seems to have been omitted, except the potentiometer, which is now so largely used in practical testing; but it may be that the author considers its proper place to be in the volume of advanced work.

There are several appendices to the volume. At the end of the descriptions of most of the experiments the author adds Inferences—questions for the student to answer as to the inferences to be drawn from the details of his work. The first appendix contains solutions of these inferences, some of which involve mathematical work. The next appendix contains a description of the different instruments used, with illustrations either from photographs taken specially or from makers' catalogues. The remaining pages might for the most part have been omitted. They contain tables of logarithms and antilogarithms, reciprocals of numbers, doubled square roots (for the Kelvin standard balance), and natural sines and tangents. Every student must have a book of mathematical tables, and there is no necessity for duplication. There is a good index to the book.

The author deserves praise for the care he has bestowed upon this book, and for the good selection of experiments which he has made. The printers also have done their work well; the different types are all clear and pleasant to read, even where the page is occupied with mathematical analysis.

Wireless Telegraphy and Hertzian Waves. By S. R. Bottone. London: Whittaker & Co., 1900.

To all those who delight in making their own scientific apparatus—and nothing will be of such assistance to the young student of science as an occasional trial of his mechanical skill—this little volume will be a welcome guide, for it contains a very clear description showing how to make a small induction coil, a Wimshurst machine, a coherer, and, in fact, all the essential apparatus required for experimenting, on a small scale, with the transmission of electric oscillations to a distance, without the use of conducting wires. Moreover, there is no doubt, that the author in the second portion of the little book, which is devoted to these practical matters, gives to the reader the results of his own experience, for he endeavours to show them how to overcome in the simplest manner the difficulties and obstacles which he knows will arise when they set to work and begin to carry out his instructions. The knowledge which he tries to convey is his own knowledge, and he conveys it in his own words. Very different is the impression made by the first portion of Mr. Bottone's book, for this portion is unequal, consisting of lucid parts intermingled with obscure paragraphs; it deals fully with matter of secondary interest and occasionally omits entirely facts of prime importance, and has altogether the appearance of patchwork. Again and again the idea forces itself upon the reader that the author has either not fully grasped himself the theory of electric oscillations and Hertzian waves, or, at all events, has no confidence in his knowledge of the subject. He seems to reproduce what others have written, rather than attempt to give his own version, and, having collected the facts from sources widely differing from each other, both as regards treatment and style, he neglects, or fails, to produce a homogeneous text. This, at all events, seems to us the only theory by which the inequality in the treatment of points of equal importance and the different sense in which the same terms are used in various parts of this first portion of the little volume can be explained. We do not wish to imply, however, that we think Mr. Bottone guilty of plagiarism, for we do not accuse him of having literally reproduced the words of other authors without giving credit to them; we merely desire to say that the writing of his manuscript appears to have been simultaneous with, or not sufficiently separated from, the quite legitimate process of collecting the data, and that for this reason the first portion of his book produces upon the reader the effect of knowledge not yet digested and assimilated. Fortunately this does not affect the second portion and its usefulness, and those who desire to understand the theory of the experiments made with their home-made apparatus, will have no difficulty in supplementing the first portion of Mr. Bottone's book by additions from the abundant literature on this subject.

Railway Runs in Three Continents. By J. T. Burton Alexander. Elliott Stock, London, 1900. Demy 8vo, 191 pp., 7/6.

This volume contains records of runs made by some of the "crack" expresses on various European, Canadian, Australian and American railways.

Each run is fully detailed, the author's notes on the trip are also given, and are in many cases of considerable interest. For instance, in speaking of the railways of Chili, he says, "The switches are not always set right . . . from what I heard from drivers the signals are chiefly misleading, and, after seeing the signal down and going into the ditch, it is no defence to say the signal showed you a clear road; they would say they expect you to see the switches set right for yourself." The bridges on the line are built for 45-ton locomotives but they have some 50 and 60-ton engines and two of 90 tons. No doubt the engine

builders have suggested the same way out of this difficulty as they proposed to Sir Walter Peace under somewhat similar circumstances, namely, that the bridges should be adapted to the locomotives. A following section of the book details runs made in Canada and in the United States. The Grand Trunk are credited with using an engine on the run from Ottawa to Montreal which will cover a mile in 30 seconds, apparently with a load of 200 tons; but their competitors, the Canadian Pacific, succeed in keeping in front of this engine with the same load, although they do not claim to run the mile in under 40 seconds. The modesty of this latter statement is indeed refreshing.

The log of these runs gives the speeds as 49 and 54 miles per hour respectively. The two lines run side by side for a short distance, and the Canadian Pacific train was slowed down for the author's friend to secure a view of one train endeavouring to pass the other when both were running at 70 miles an hour.

The runs made in the United States are of particular interest, owing to the exaggerated reports which have been published of the speeds of such trains as the Empire State and Black Diamond expresses: the log of the former run gives an average speed of 57 miles an hour, over a distance of 439 miles, with four stops, taking 21 minutes. The total running time was eight hours, eleven minutes, and the load 210 tons. A fine performance.

The fastest start to stop run was 80 miles in 77¼ minutes—62 miles per hour. Three engines were employed throughout the trip; the longest distance run without a stop being from Syracuse to Buffalo, 148 miles, at a speed of 59 miles per hour.

One of the drivers informed the author that he had run this train over the above section for a year without losing a minute.

Mr. Burton Alexander is of opinion that the leading eastern railroads of the United States have come fully into line with the best English practice in the matter of permanent way; but it is difficult to see how he arrives at this conclusion, as the rails are spiked direct to the sleepers. He also notes that the adoption of electro-pneumatic switches and signals enables heavy traffic to be dealt with more readily than is the case on this side of the Atlantic; but in referring to some slowing-up experienced on a run with the Black Diamond express, he remarks that this was due to the failure of automatic signals, and points out that breakdowns of this nature would be terribly awkward if a great volume of traffic were continuously passing over the line.

The author's experiences in the United States doubtless afforded him considerable satisfaction, and he chronicles several fine performances; but it is to be regretted that his enthusiasm should have led him to state that "while absolute reliance can be placed on American schedules, in this country the time-table seems to be a pinnacle of perfection which it is vainly hoped to attain in practice."

This is more the language of an "irresponsible scribbler" or a youthful "railwayac," than the opinion of an experienced observer. It would of course be easy to take Mr. Burton Alexander too seriously, but as his book is intended for circulation amongst the various officials to whom he is indebted for the facilities afforded him for making these records, it is as well to draw attention to these discrepancies.

It will indeed be gratifying to British locomotive superintendents to learn that in spite of his wanderings the author finds it possible to express his admiration for one or two of their creations, although the runs he has made in this country are certainly below the average.

It is also interesting to read that the East Coast joint stock is "far away ahead of the stock used on other routes to the North." This shows a grasp of detail which will be fully appreciated in railway circles.

The appendix records some remarkable trips with the De Glehn compounds on the Great Northern of France. These locomotives were fully described and illustrated in FEILDEN'S MAGAZINE for May, 1900, and give results which are not at present equalled on this side of the Channel, one noteworthy record being a speed of 55 miles an hour, with a train of 235 tons, up a bank of 1 in 125, 8 miles in length.

Although too much importance is apt to be attached to high rates of speed, it is well to be able to refer to trustworthy records for information on this subject, and Mr. Burton Alexander's book should, on the whole, prove of value in this connection. It is, however, disfigured by a number of blemishes, and needs a more systematic arrangement of the various details given; those referring to locomotives and gradients should be amplified, while any information as to the coal consumption per train mile would be acceptable. With the above exceptions the general appearance of the book is excellent.

BOOKS RECEIVED.

Marine Boiler Management and Construction, by C. E. Stromeyer, M.Inst.C.E., Longmans, Green & Co., 12/- net.

Electrical Designs, reprinted from *The American Electrician*, American Electrician Co., New York, $2.00.

Original Papers by the late John Hopkinson, D.Sc., F.R.S., edited by B Hopkinson, B.Sc., The University Press, Cambridge, 2 vols., 21/- net.

The Management of Engineering Workshops, by Arthur H. Barker, Wh.Sc., B.A., B.Sc., The Institution of Junior Engineers, 39, Victoria Street, Westminster, 3/-.